NOTICE

All drawings located at the end of the document.

Final
Phase III RFI/RI

Rocky Flats Plant
881 Hillside Area

(Operable Unit No. 1)

June 1994

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EXECUTIVE SUMMARY

This document presents the results of the Environmental Evaluation (EE) conducted for the Phase III RCRA Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit 1 (OU1) at the U.S. Department of Energy (DOE) Rocky Flats Plant (RFP) near Golden, Colorado. The OU1 Phase III RFI/RI was intended to investigate potential contamination of soils, groundwater, surface water, sediment, and biota that potentially had been contaminated through waste disposal practices and accidental release of hazardous substances into the environment. The RFI/RI process includes a Baseline Risk Assessment which has two components: the Public Health Evaluation and the EE.

The overall goals of the OU1 EE are to ascertain whether contamination resulting from RFP plant activities at the 881 Hillside buildings and adjacent areas may have impacted or could adversely impact ecological receptors in the immediate vicinity. Data from Phase I, II, and III RFI/RI activities were used to evaluate the distribution and concentration of suspected contaminants in abiotic media. Prior to this EE, no ecological or toxicological investigations had been conducted at OU1. Therefore, all of the toxicological and ecological data used were collected during the EE or other elements of the Phase III investigations.

The locations of the OU1 Individual Hazardous Substance Sites (IHSSs) were identified on the basis of historical information, aerial photographs, and preliminary site data. Aerial photographs indicated some physical disturbance in IHSSs 119.1 and 119.2 when the sites were being actively used as waste storage areas. There was also evidence of past physical disturbance due to construction of roads and the South Interceptor Ditch (SID), and a large area of OU1 had been re-seeded with pasture grasses. However, visual inspection of the OU1 area prior to the start of Phase III RFI/RI field activities in 1991 revealed no areas of obvious ecological stress in IHSSs or downgradient areas upon which to focus the investigation (EPA, 1989b). Since there was an apparent contaminant source, but no known effects or exposures, the motivation for the OU1 EE was "source-driven" (Suter, 1993). The potential stressors, the chemical contaminants in the IHSSs, were not definitively known prior to the investigation of abiotic media associated with the Phase III RFI/RI.

Subsequent analysis of data on the nature and distribution of contaminants in abiotic media was used to identify a list of contaminants of concern (COCs). The COCs identified were selenium, plutonium-239,-240, americium-241, total uranium, carbon tetrachloride, dichloroethene, trichloroethane, trichloroethene, tetrachloroethene, toluene, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Concentration of COCs in abiotic media and in biotic tissue were used to estimate exposure of key ecological receptors to COCs. In some cases screening-level models were used to extrapolate from COC concentrations in abiotic media or tissue samples to exposure of upper-level consumers in the local food web. The exposure assessment was coupled with investigations of the community structure to ascertain whether the predicted toxicity was manifested in ecological effects.

Exposures were estimated for vegetation, small mammals (rodents), mule deer, coyotes, red-tailed hawks, great horned owls, and bald eagles. Exposure pathways assessed included dermal contact, ingestion, inhalation, and bioaccumulation. Estimated exposures were compared to benchmark concentrations, ecological effects criteria and toxicity reference values (TRVs), that were developed in the Toxicity Assessment to represent contaminant concentrations that would not result in toxic effects. Risk from exposure was then assessed based on the probability of exceeding the critical values. Simulation modeling was used to estimate the probability of exceeding the criteria.

Concentrations of volatile organic compounds in groundwater exceeded the ecological effects criterion for exposure of vegetation in IHSS 119.1. The total area exceeding the criterion was small, estimated at 0.04 hectares, or about 0.04 percent of the OU1 ecology study area. The depth to groundwater in this area varies with season and ranges from 2 to 4.5 meters. The vegetation is primarily grasses and forbs whose roots are concentrated in the upper 0.3 meters of soil. Therefore, the frequency at which vegetation roots contact contaminants in groundwater in this area is likely to be low. Deeper rooted species such as woody shrubs and phreatophytes occur in the Woman Creek riparian corridor. However, this area is approximately 100 meters south with the French Drain groundwater intercept system between it and IHSS 119.1.

Soils in about 4 percent of OU1 contained organic contaminants exceeding ecological effects criteria. PAH concentrations in soils exceeded the effects criterion for dermal contact with burrowing mammals in a total of about 2 hectares, or 2 percent of the OU1 area. Areas exceeding the effects criterion were located in IHSSs 104 and 130. Toluene concentrations in soils outside IHSSs exceeded the ecological effects criteria for exposure of burrowing mammals to air inside the burrows. This area included about 2 hectares, mostly outside the IHSS boundaries.

The probability of exceeding ecological effects criteria through ingestion and bioaccumulation pathways did not exceed 8 percent for any receptor-COC combination except selenium ingestion by great horned owls. However, tissue analysis indicated that selenium concentrations in the owls' food within OU1 were at natural levels. Therefore the probability of selenium poisoning in OU1 is no higher than that in natural unimpacted areas of Rocky Flats.

PCB distribution in soils at OU1 was restricted to a 2 hectare area around IHSS 119.1 and 119.2. This area is much smaller than the home range of the major predators at Rocky Flats. Bioaccumulation models indicate that the probability of reaching toxic body burdens is less than 5 percent for great horned owls and less than one percent for coyotes, and red-tailed hawks. Likewise, radionuclide concentrations were three to five orders of magnitude below levels that could result in toxic tissue concentrations.

There was no evidence that potential transport of contaminants from OU1 has resulted in toxicities to ecological receptors. Toxicity screens conducted for the SID and Woman Creek indicate that OU1 contributes no additional toxicity to these aquatic sites. Preliminary results from the Operable Unit No. 5 (OU5) Phase I RFI/RI corroborate these results and indicate that sediments in Woman Creek, Pond C-1, and Pond C-2 are also non-toxic to standard laboratory test organisms.

The grassland communities in the OU1 IHSS area were somewhat less diverse than its counterpart in the reference areas. However, these differences are not necessarily due to the effects of contamination. Rather, these effects may be due to the physical disturbance to which the site has been subjected. In addition, attempts at reclaiming disturbed areas with introduced grasses has resulted in areas that are near monocultures, resulting in lower diversity in vegetation communities. This lower diversity was not reflected in the wildlife use of the area. Small mammals were as abundant in OU1 as in reference areas. Furthermore, Preble's jumping mouse, an indicator of good habitat quality, was captured in the OU1 area.

By contrast, the riparian corridor along Woman Creek contained a rich and diverse ecological community. Both grassland and wooded areas contained primarily native components indicating a lack of effect from human activities and/or recovery from previous grazing. The banks of the creek are highly vegetated and stable which contributes to the good habitat and water quality in the creek and in Pond C-1. The area also supports sensitive animal species such as Preble's jumping mouse, the water shrew, and several species of songbirds.

Woman Creek and Pond C-1 support fish and benthic fauna typical of good water and habitat quality. Largemouth bass and green sunfish are found in Pond C-1 indicating a fish and invertebrate prey base that is rich enough to support these predators. The pond also supports a population of stonerollers and fathead minnows. Largemouth bass, stonerollers, and fathead minnows are all indicators of good water quality. Fathead minnows are used in standard EPA toxicity tests. Woman Creek supports a diverse benthic macroinvertebrate community including pollution intolerant species such as caddisflies and mayflies.

In summary, results of the EE suggest that while some contaminants occur at potentially toxic levels, the contaminated areas are not large enough to result in a significant threat to the populations of plants or animals in the Woman Creek drainage. The restricted distribution limits the duration and frequency at which ecological receptors may contact contaminants, thus limiting exposure. In addition, only a fraction of local populations will contact environmental media within the OU1 IHSSs. The community in the OU1 IHSS area appears to have been impacted primarily through physical disturbance and revegetation efforts. If allowed, disturbed areas can probably regenerate through natural processes. Areas adjacent to OU1, but outside the disturbed sites, support a native and diverse biological community, including several sensitive species.

APPENDIX E—ENVIRONMENTAL EVALUATION

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LIST OF ACRONYMS AND ABBREVIATIONS

AQUIRE	Aquatic Information Retrieval
AWQC	Ambient Water Quality Criteria
atm	atmosphere
BAF	bioaccumulation factor
BCF	bioconcentration factor
BMF	biomagnification factor
BRA	baseline risk assessment
BW	body weight
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDH	Colorado Department of Health
cm	centimeter
COC	contaminant of concern
CRQL	contract-required quantitation limit
CSU	Colorado State University
DCA	dichloroethane
DCE	1,1-dichloroethene
dis	disintegration
DOE	U.S. Department of Energy
EC_{50}	median effective concentration
EE	Environmental Evaluation
EEC	ecological effects criterion
EEW	Environmental Evaluation Work (Plan)
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FBI	family biotic index
FSP	field sampling plan
g	gram
GAC	granular-activated carbon
g/m^2	grams per square meter
ha	hectare
HBI	Hilsenhoff Biotic Index
IAEA	International Atomic Energy Agency
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
kg	kilogram
km	kilometer
K_{ow}	octanol-water partition coefficient
K_p	sediment/water partitioning coefficient
L	liter
LC_{50}	median lethal concentration

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

LEC	lowest-effects concentration
LD_{50}	median lethal dose
LOAEC	lowest-observed adverse effects concentration
LOAEL	lowest-observed adverse eff
LOEL	lowest-observed effects level
m	meter
m^2	square meter
MATC	maximum allowable tissue concentration
mi	miles
mi^2	square miles
mg/kg	milligram per kilogram
mg/L	milligrams per liter
mph	miles per hour
μg/kg	micrograms/per kilogram
NOAEC	no-observed adverse effects concentration
NOAEL	no-observed adverse effects level
NOEL	no-observed effects level
NRDA	National Resource Damage Assessment
OU1	Operable Unit No. 1
OU2	Operable Unit No. 2
OU5	Operable Unit No. 5
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi	picoCuries
pdf	probability density function
PHE	Public Health Evaluation
ppm	parts per million
QA/QC	quality control/quality control
RBP	Rapid Bioassessment Protocol
RCRA	Resource Conservation and Recovery Act
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RfD	reference dose
RfC	reference concentration
SARA	Superfund Amendments and Reauthorization Act
sd	standard deviation
SID	South Interceptor Ditch
SQC	Sediment Quality Criteria
SVOC	semivolatile organic compound
TCA	trichloroethane
TCE	trichloroethene
TIE	toxicity identification evaluation

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TRV	toxicity reference value
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
VOC	volatile organic compound
WQC	water quality criterion for continuous exposure
WQCC	Water Quality Control Commission

SECTION E1
INTRODUCTION

This document presents the results of an Environmental Evaluation (EE) conducted for the Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 1 (OU1) at the U.S Department of Energy (DOE) Rocky Flats Plant (RFP) near Golden, Colorado. OU1 includes 11 Individual Hazardous Substance Sites (IHSSs) on or near the 881 Hillside (Figure E1-1). The RFI/RI process at Rocky Flats is intended to address requirements of RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for investigations at sites potentially contaminated with hazardous substances. The purpose of OU1 Phase III RFI/RI was to investigate potential contamination of soils, groundwater, surface water, sediment, and biota that potentially have been contaminated through waste disposal practices or accidental releases of hazardous substances at OU1. The RFI/RI process includes a Baseline Risk Assessment (BRA), which has two components: the Public Health Evaluation (PHE) and the EE.

This EE was implemented according to the *Final Phase III RFI/RI Environmental Evaluation Work Plan* (EEW) (DOE, 1991a). The EEW was prepared in accordance with the U.S. Environmental Protection Agency's (EPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988a), *Risk Assessment Guidance for Superfund Volume II: Environmental Evaluation Manual* (EPA, 1989a), and *Ecological Assessments at Hazardous Waste Sites: A Field and Laboratory Reference Document* (EPA, 1989b). Although the Natural Resource Damage Assessment (NRDA) process has not been initiated at Rocky Flats, the EEW was also prepared to be as consistent as possible with its requirements. Data analysis and report preparation also followed more recent EPA guidance as set forth in *Framework for Ecological Risk Assessment* (EPA, 1992a).

E1.1 PURPOSE AND SCOPE

The overall goal of the OU1 EE was to ascertain whether contamination resulting from RFP activities in Building 881 and adjacent areas may have impacted or could adversely impact ecological receptors in the immediate vicinity. Ecological receptors are operationally defined as plants and animals other than humans and domesticated species (EPA, 1989a). This study was not designed to prove a causal relationship between specific chemicals and existing impacts (EPA, 1989a, 1992a). Rather, it was designed to use a weight-of-evidence approach to assess whether adverse ecological impacts have occurred, whether they are due to site contaminants, and to assess the likelihood of future adverse impacts resulting from site contamination. The approach adopted for the OU1 EE addresses possible effects of contamination at multiple levels of biological organization, including populations, communities, and the ecosystem. Data from Phase I, II, and III RFI/RI activities were used to evaluate the distribution and concentration of suspected contaminants in abiotic media. Prior to this EE, no ecological or toxicological investigations had been conducted at OU1. Therefore, all of the toxicological and ecological data used were collected during the EE or other elements of the Phase III RFI/RI.

As an interim remedial action, a French Drain was installed to intercept and collect contaminated groundwater for subsequent treatment. Most of the ecological and toxicological data were collected before the French Drain was installed. Installation of the French Drain had significant impact on the structure of the ecological community at OU1. The results presented in this EE report address impacts and potential hazards due to conditions that existed before installation of the French Drain. Results of the OU1 EE will also be used to assess the potential environmental impact of further remedial action at OU1 and to ensure that the remedial action protects the environment.

E1.2 APPROACH

Implementation of the OU1 EE followed the ten-task model outlined in the EEW (DOE, 1991a)(Figure E1-2). Tasks 1 and 2 included the evaluation of existing data and initial site visits to determine contaminants of concern (COCs); potential ecological receptors; and ecological, toxicological, and chemical endpoints to be considered in developing the final field sampling plan. These tasks were largely completed as a result of preparation of the EEW and the OU1 Field Sampling Plan (FSP)(DOE, 1991b). The Task 3 ecological field investigations were performed according to the FSP and were conducted during the period May 1991 through February 1992. Tasks 4 through 9 included ecological impact assessment, characterization of COC toxicity, and estimation of exposure to COCs. These tasks entailed analysis of ecological field data, laboratory data on chemical concentrations in biotic tissues and abiotic media, and the available scientific literature. Task 10 was the preparation of this EE report.

The locations of the OU1 IHSSs were identified on the basis of historical information, aerial photographs, and preliminary site data. Aerial photographs indicated some physical disturbance in IHSSs 119.1 and 119.2 when the sites were being actively used as waste storage areas. There was also evidence of past physical disturbance due to construction of roads and the South Interceptor Ditch (SID) and a large area of OU1 had been re-seeded with pasture grasses. However, visual inspection of the OU1 area prior to the start of Phase III RFI/RI field activities in 1991 revealed no areas of obvious ecological stress in IHSSs or downgradient areas upon which to focus the investigation (EPA, 1989b). Since there was an apparent contaminant source, but no known effects or exposures, the motivation for the OU1 EE was "source-driven" (Suter, 1993). In addition, the potential stressors—the chemical contaminants in the IHSSs—were not definitively known prior to the investigation of abiotic media associated with the Phase III RFI/RI, although preliminary data from the Phase I and II RFI/RI were used to identify several potential contaminants and target analytes for tissue analysis. Due to schedule constraints arising from the requirements of the Interagency Agreement (IAG), the field investigation associated with the OU1 EE was to be completed before results of Phase III abiotic investigations were available and a definitive list of chemical stressors could be identified. Thus, the OU1 EE adopted an approach in which general indicators of ecological stress were evaluated and a broad spectrum of potential tissue contaminants were analyzed.

Results of the Phase III abiotic investigations on the nature and distribution of contaminants in abiotic media were used to identify COCs. Concentrations of COCs in abiotic media and in biotic tissue were used to estimate exposure of key ecological receptors to COCs. In some cases models were used to extrapolate from COC concentrations in abiotic media or tissue samples to exposure of upper level consumers in the local food web. In all cases, estimation of exposure adopted a screening-level approach employing conservative models and assumptions so that the chance of underestimating exposure and risk was minimized, but a degree of accuracy was retained (Kirchner, 1993; Suter, 1993). The screening models used were of low complexity and aggregated data from exposure units appropriate to the individual receptors. The results of the exposure assessment were integrated with results of population- and community-level measurements to evaluate current impacts and risk of impacts.

Field data were collected to characterize the ecological communities and the food web at OU1. Vegetation, small mammals, terrestrial arthropods, benthic macroinvertebrates, and fish were collected from areas in and around OU1. Similar data were collected from an unimpacted area in the Rock Creek drainage north of the industrial complex of RFP. Quantitative comparisons between OU1 and the Rock Creek data were conducted for vegetation community parameters. Wildlife data were not quantitatively evaluated because the relatively small area of OU1 and its proximity to the industrial complex prevented meaningful comparisons.

E1.2.1 Assessment Endpoints

Assessment endpoints are formal expressions of the ecological resources to be protected. Characteristics of assessment endpoints should include relative importance in the local biological system and societal recognition as important ecological resources (Suter, 1990, 1993). Identification of assessment endpoints is necessary to focus the resources of an investigation on a few valued parameters and avoid analysis of unnecessarily diffuse and unrelated factors in the environment. Because the nature and extent of contamination was so poorly known prior to field work, the collection of ecological data at OU1 focused on assessment endpoints, such as community composition and structure, that are general indicators of environmental stress. Identification of chemical stressors allowed analysis associated with the exposure assessment and risk characterization to focus on assessment endpoints relevant to the potential ecotoxicity of the COCs. For example, the potential exposure of top avian and mammalian predators was assessed for COCs known to biomagnify. The following assessment endpoints were evaluated:

- **Vegetation Community** — Soil and groundwater contamination can result in direct exposure of vegetation to contaminants. Presence of phytotoxic levels of contaminants at OU1 could alter the composition and structure of the vegetation community at OU1 and result in decreased wildlife habitat quality. The composition and structure of the vegetation community at OU1 was assessed using a variety of measured variables. The endpoints evaluated were vegetation cover, production, richness, and diversity in the study area in comparison to analyses to reference area communities in unimpacted portions of the plant site. The assessment also included the likelihood of adverse impacts from potentially toxic exposures at OU1.

- **Small Mammal Community** — Small mammals may be exposed to contaminants through ingestion of contaminated vegetation or prey, or through direct contact with contaminated media. Mice and voles are significant components of total biomass in most grassland ecosystems and are important primary and secondary consumers. They can also be a conduit for transfer of contaminants to upper-level consumers. In addition, the home range of most species of mice and voles is small enough that they probably spend all or most of their lives in the OU1 area. A potential decrease in the prey base or potential toxicity of prey due to bioaccumulation has clear relevance to the welfare of top predators. Local populations were assessed with respect to areas of similar habitat on the plant site. In addition, the exposures of small mammals to site contaminants were estimated and the potential toxicity evaluated. The probability of exceeding toxic thresholds was evaluated using tissue concentrations and/or models for ingestion, inhalation, and bioaccumulation pathways.

- **Mule Deer Population** — Substantial resident mule deer population exists at Rocky Flats, and mule deer are known to use areas downgradient of OU1. Mule deer are large, conspicuous mammals, and the health and vigor of the population is a societal indicator of ecological health. The exposure of mule deer to site contaminants in vegetation, soil, and surface water was evaluated for potential toxicity.

- **Toxic Exposure to Top Predators** — The coyote, red-tailed hawk, and great horned owl are important predators at Rocky Flats, and their welfare has clear societal relevance. These species could potentially forage in the OU1 area and thus become exposed to any contaminants that have bioaccumulated in their prey. Potential exposures to these species were estimated from results of abiotic and biotic investigations. The probability of exceeding toxic thresholds was estimated using models to extrapolate exposure concentrations from exposure points.

Measurement endpoints used to evaluate the assessment endpoints are discussed in Sections E6 and E7.

E1.2.2 Correspondence of the EEW Tasks to EPA's Framework for Ecological Risk Assessment

The OU1 EEW was developed prior to publication of the EPA's *Framework for Ecological Risk Assessment* (EPA, 1992a) and, therefore, did not benefit from EPA's most recent guidance on performing ecological risk assessments. However, a correlation can be drawn between the three phases of the "Framework" and the components of the ten-task scheme presented in the OU1 EEW. This correlation is depicted in Figure E1-3 and is discussed below.

The Problem Formulation Phase of the Framework process is intended to establish the goals, breadth, and focus of the investigation (EPA, 1992a). The motivation for the risk assessment is established, and the potential stressors and receptors identified. These activities were accomplished primarily in Tasks 1, 2, 5, and 8 of the ten-task scheme (Figure E1-2). The potential effects of contaminant exposure and the endpoints to be assessed are also identified in these tasks.

The Analysis Phase of the Framework process is intended to evaluate data to estimate exposures of the ecological receptors to site contaminants and to determine whether impacts have occurred or are likely to occur as a result of exposure. Technically, this phase is not intended to include data collection. Rather, it is intended for the analysis of existing data and assessment of further data needs. In the OU1 EE, data on ecological community structure and tissue contaminant loads were collected under Tasks 3 and 9. Data analysis for exposure estimations was conducted under Tasks 5, 6, and 10. Analysis of ecological field data collected during Task 3 was conducted under Task 10.

The integration of exposure and ecological effects assessment is the function of the Risk Characterization Phase. This phase includes evaluation of the likelihood that adverse effects will occur as a result of the exposures estimated. The evaluation includes assessment of the uncertainty associated with measurements and assumptions used in generating the exposure assessments. The integration of exposure and ecological effects information was accomplished under Task 10. Uncertainty associated with the toxicity assessment, exposure assessment, and ecological effects characterization was assessed in Tasks 4, 5, and 10.

E1.3 ORGANIZATION OF THIS DOCUMENT

The OU1 EE presents the results and conclusions of the ecological risk assessment performed for the Phase III RFI/RI BRA. This document is Appendix E of the OU1 Phase III RFI/RI Report and is based in part on findings described in other portions of that report. A detailed description of the site history, previous investigations, and the Phase III RFI/RI is presented in Sections 1 through 4 of the main report.

The structure of this report is based on the proposed outline presented in the EEW (DOE, 1991a). However, slight deviations from the proposed outline were necessary to accommodate presentation of results.

A general description of the physiography, meteorology, and ecology of Rocky Flats and the OU1 study area is presented in Section E2, Site Description. Data collected during ecological investigations at OU1 also are presented in Section E2. A brief description of the OU1 IHSSs, the contaminant source areas, is presented in Section E3, Contaminant Sources and Releases.

The process of identifying COCs and the data on which selection was based is presented in Section E4, Contaminants of Concern. The potential toxicity of the COCs and development of benchmark values used to evaluate risk is presented in Section E5, Toxicity Assessment. Exposure assessment methodology and results are presented in Section E6 along with a discussion of the associated uncertainty. Comparisons of OU1 and Rock Creek data, along with the design, methods, and results of ecological and ecotoxicological investigations are presented in Section E7, Characterization of Ecological Effects.

Section E8, Uncertainty, contains a summary and discussion of the uncertainty associated with the results of ecological and ecotoxicological analyses. Section E9, Conclusions, was intended to integrate and summarize the results of the ecological and toxicological investigations. This section corresponds to the Risk Characterization Phase of the Framework process. However, detailed discussions of the exposure assessment and ecological effects characterization results are presented in their respective sections.

ECOLOGICAL RISK ASSESSMENT

PROBLEM FORMULATION

Characterize Stressors: 1.2, 2.2
Ecosystem Potentially at Risk: 1.2, 2.1, 2.2
Ecological Effects: 2.4
Endpoint Selection: 1.4, 2.3
Conceptual Model: 1.5, 1.6, 2.4, 5.1, 8.1, 8.2

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ANALYSIS

EXPOSURE CHARACTERIZATION
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Exposure Analysis: 5.1
Exposure Profile: 5.2, 5.3

ECOLOGICAL EFFECTS CHARACTERIZATION
Ecosystem Characterization: 3.2, 9.0
Relevant Effects Data: 4.1, 4.2, 4.3
Ecological Response Analysis: 6.1, 6.2
Stressor-Response Profile: 5.2, 5.3

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RISK CHARACTERIZATION

RISK ESTIMATION
Integration: 10.1, 10.2
Uncertainty Analysis: 5.1, 5.2, 5.3, 7.0

RISK DESCRIPTION
Risk Summary and Interpretation: 10.3, 10.4

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant Golden Colorado

881 HILLSIDE AREA
OPERABLE UNIT NO. 1
PHASE III RFI/RI REPORT

CORRESPONDENCE BETWEEN OU1 EE WORKPLAN
SUB-TASKS AND EPA's
"FRAMEWORK FOR ECOLOGICAL RISK ASSESSMENT" [a]
Figure E1-3

[a] EPA 1992

SECTION E2
SITE DESCRIPTION

The purpose of this section is to describe the physical setting and general ecology of OU1 and RFP. Ecological descriptions are based, in part, on data collected from OU1 and the reference area in the Rock Creek drainage north of the industrial complex (Figure E2-1). These data were collected to characterize site ecology and to provide qualitative and quantitative comparisons between OU1 and reference area communities. Data for habitats in OU1 are presented in this section. Comparisons of ecological community data from the OU1 study area and the reference areas are presented in Section E7. The processes and criteria used to identify the reference area are described in Section E7.1.

E.2.1 PHYSICAL ENVIRONMENT

E2.1.1 Physiography and Topography

The natural environment of RFP and vicinity is influenced primarily by its proximity to the Front Range of the Southern Rocky Mountains. RFP is located less than 2 miles east of the north-south trending Front Range and approximately 16 miles east of the Continental Divide. This transition zone between prairie and mountains is referred to as the Colorado Piedmont section of the Great Plains province (Thornbury, 1965; Hunt, 1967).

The Colorado Piedmont is an area of dissected topography reflecting folding and faulting of bedrock along the edge of the Front Range uplift, subsequent pediment erosion and burial by fluvial processes, and more recent incision of drainages and removal of portions of the alluvial cap. Rocky Flats is the most extensive pediment surface in the area. RFP occupies the eastern edge of this pediment, which extends approximately 5 miles northeast from the mouth of Coal Creek Canyon. The surface of Rocky Flats lies at an elevation of approximately 6,000 feet above mean sea level. In eastern portions of RFP, the nearly flat pediment gives way to lower, more rolling terrain.

E2.1.2 Meteorology and Climate

The region has a highly continental, semi-arid climate characteristic of much of the southern Rocky Mountain region. Mean annual precipitation is approximately 17 to 18 inches, based on 20-year means for Boulder and Lakewood, Colorado (NOAA, 1992). The wettest season is spring (March through May), which accounts for about 40 percent of the total annual precipitation. This season typically includes occasionally heavy snow as well as periods of steady rain. Precipitation gradually declines through the summer, usually occurring as brief but intense thunderstorms. The period June through August contributes about 30 percent of the annual total. Autumn and winter account for 19 and 11 percent of the total, respectively. Snowfall commonly occurs as early as September and as late as May; the 85-inch mean annual snowfall provides approximately half of the total moisture for the year. Annual free-water (pan) evaporation is approximately 45 inches, roughly 2.5 times the annual precipitation. Relative humidities average approximately 46 percent.

Temperatures at RFP exhibit large diurnal and annual ranges but are generally moderate. Periods of extremely hot or cold weather are usually brief and may not occur every year. Average minimum and maximum temperatures, based on 20-year means for Boulder and Lakewood, Colorado, are approximately 19 degrees Fahrenheit (°F) and 45°F in January and 59°F and 88°F in July (NOAA, 1992). Temperatures as low as -25°F and as high as 105°F have been recorded at these monitoring locations. The mean annual temperature is 52.1°F for Boulder and 50.5° for Lakewood.

RFP is noted for its strong winds. Gusty winds frequently occur with thunderstorms and the passage of weather fronts. The highest wind speeds occur during the winter as westerly windstorms known as chinooks. The windstorm season at RFP extends from late November into April; the height of the season usually occurs in January. Windstorms at RFP typically last 8 to 16 hours and are very gusty in nature. RFP experiences wind speeds exceeding 75 miles per hour (mph) in almost every season; gusts exceeding 100 mph are experienced every 3 to 4 years. Northwesterly wind directions and wind speeds under 15 mph are the predominant wind conditions at RFP. Moderately strong northerly or southerly winds are common in winter and summer, respectively, and easterly winds ("upslopes") may be associated with snowfall.

E2.1.3 Geology

E2.1.3.1 Bedrock Geology

The Upper Cretaceous Arapahoe and Laramie Formations unconformably underlie surficial materials in the vicinity of OU1. The Arapahoe Formation is composed primarily of sandstones, siltstones, and claystones that are very similar lithologically to those in the underlying Laramie Formation. The Arapahoe Formation is generally not present except atop the highest interfluves (divides), where it is protected by the coarse alluvial caprock.

E2.1.3.2 Surficial Geology

Four distinct surficial deposits of Quaternary age are present in the vicinity of OU1: Rocky Flats Alluvium, colluvium (slope wash), valley-fill alluvium, and artificial fill or disturbed ground. These surficial deposits unconformably overlie the bedrock units. Rocky Flats Alluvium caps the interfluves (ridges) north and south of Woman Creek. Colluvium covers the hillsides down to the drainage. Valley-fill alluvium is present along the channel of Woman Creek and its tributaries. The erosional surface on which the alluvium was deposited slopes gently eastward, truncating the Arapahoe and Laramie Formations. Artificial fill or disturbed surficial materials are present within the boundaries of OU1, as well as other areas within the Woman Creek Drainage (especially in OUs 2 and 5).

Rocky Flats Alluvium

Rocky Flats Alluvium is the oldest alluvial deposit present at RFP and caps the broad pediment surface that gave the alluvium its name. Rocky Flats Alluvium is described as an angular to subrounded, poorly sorted, coarse, bouldery gravel in a sand matrix with lenses of clay, silt, and varying amounts of caliche. Pebbles, cobbles, and boulders are composed primarily of quartzite, with lesser amounts of other metamorphic, igneous, and sedimentary rocks derived from Coal Creek Canyon. Deposits of Rocky Flats Alluvium in the area of OU1 are 10 to 20 feet thick.

Colluvium

Colluvium mantles hillsides along drainages that dissect the Rocky Flats Alluvium. The colluvium consists primarily of clay with common occurrences of silty clay, sandy clay, and gravelly clay. Thicknesses along the Woman Creek drainage range from 5 to 20 feet.

Valley-Fill Alluvium

The most recent deposit in the OU1 area is valley-fill alluvium along the floor of the Woman Creek valley and its tributaries. The valley fill consists of poorly sorted sand and gravel in a silty clay matrix and is derived from reworked and redeposited older alluvial and bedrock materials. Thicknesses along Woman Creek range from 4 to 8 feet.

Artificial Fill

Portions of RFP are underlain by artificial fill. In the OU1 area, the fill appears to have been derived from Rocky Flats Alluvium, colluvium, and claystone bedrock. Fill thickness are highly variable but reach depths of 12 to 20 feet south and west of Building 881.

E2.1.4 Soils

In general, soils at Rocky Flats have formed from alluvial, colluvial, and eolian deposits of Quaternary age. The area consists of a nearly level to gently east-sloping system of coalescing fans, modified by fluvial erosion to form moderately to steeply sloping hillsides, elongated ridgetops or divides, and terraces adjacent to narrow flood plains. The soils are characterized by two broad soil associations, the Denver-Kutch and Flatirons-Veldkamp. Denver-Kutch soils are deep to moderately deep, well-drained, clayey soils that formed in material derived from mudstone and shale. They are found mainly on moderately to steeply sloping terraces, hillsides, and fans. Flatirons-Veldkamp soils are deep, well-drained, cobbly and gravelly soils that formed on mixed alluvium. These soils occur primarily on nearly level to steeply sloping terraces, hillsides, and fans, as well as on stable summits.

Surface soils at OU1 are predominantly deep, well-drained loams, clay loams, and very cobbly sandy loams with moderate to slow permeability. Soils along the flood plain and low terraces of Woman Creek consist of stratified loamy alluvium of the Haverson series. Soils at the top of the hillside, where gravel and cobbles of Rocky Flats Alluvium are common, consist of gravelly and sandy loam of the Flatirons series. Along the slope of the hill, soils consist of cobbly to sandy loamy alluvium from the Nederland series and clay loams from the Denver-Kutch-Midway series. Runoff is generally rapid, and erosion can be severe on the steep portions of the hillside.

Most of the soils series in OU1 are classified within the Argiustoll great group. Argiustolls are typically well-drained soils with mollic (dark) epipedons or A-horizons, argillic (clayey) B-horizons, and calcic C-horizons. They form in aridic and ustic (limited moisture) regimes that are adequate for plant growth.

E2.1.5 Hydrology

E2.1.5.1 Surface Water

Three intermittent streams drain RFP, with general flow toward the east or northeast. These drainages are Rock Creek, Walnut Creek, and Woman Creek. Rock Creek drains the northwestern corner of RFP and flows northeast through the Buffer Zone to its offsite confluence with Coal Creek. An east-west trending interfluve separates the Walnut and Woman Creek drainages. North and South Walnut Creeks and an unnamed tributary drain the northern portion of the Protected Area. These three forks of Walnut Creek join in the Buffer Zone and flow toward Great Western Reservoir, which is approximately 1 mile east of the confluence. Flow is currently routed around Great Western Reservoir by the Broomfield Diversion Canal operated by the City of Broomfield.

Woman Creek drains the southern portion of RFP and flows eastward to Mower Reservoir and Standley Lake. The Woman Creek drainage basin covers an area of approximately 3.1 square miles (mi^2) or 2,000 acres. Pond C-1 is located along Woman Creek below OU1.

The SID collects runoff from the southern portion of the industrial area and diverts it into Pond C-2, where it is monitored for water quality. Water from C-2 is either evaporated or treated and pumped to the A-series ponds on North Walnut Creek for treatment.

E2.1.5.2 Groundwater

The uppermost aquifer at RFP is unconfined and composed of Rocky Flats Alluvium, valley-fill alluvium, colluvium, bedrock sandstones, and weathered claystones of the Arapahoe and Laramie Formations. Groundwater flow directions at RFP are from higher elevations in the west to lower elevations in the east and generally mimic local topography. Sources of recharge to the uppermost aquifer include infiltration of precipitation (rain and snowmelt) and seepage from surface water in ditches, streams, and ponds. Discharge occurs as evapotranspiration and as intermittent seeps where the water table intersects the ground surface or surface water features. Groundwater levels at RFP rise annually in response to spring recharge and decline during the remainder of the year as precipitation and runoff decrease.

E2.2 BIOTIC ENVIRONMENT

The following sections contain general descriptions of the ecological communities at Rocky Flats and specifically within OU1. Data resulting from surveys conducted within OU1 during 1991 field season are also presented. Raw data from community analyses are presented in Attachment E-2. A comparison of these data to reference area data is presented in Section E7. The following discussion uses common names of flora and fauna. Scientific (Latin) names of species cited are listed in Attachment E-5.

E2.2.1 Vegetation

RFP is located immediately below the elevation at which plains grasslands grade abruptly into lower montane (foothills) forests. The present vegetation of Rocky Flats is dominated by mixed prairie showing some residual influence of previous grazing (see Marr, 1964; Clark *et al.*, 1980). Prevalent upland grasses include blue grama, side-oats grama, prairie junegrass, western wheatgrass, Canada bluegrass, and native Kentucky bluegrass. Moister sites support remnants of midgrass and tallgrass prairie, including little bluestem, big bluestem, switchgrass, yellow Indiangrass, green needlegrass, and sleepy grass. Drier sites may be typified by needle-and-thread, red three-awn, buffalo grass, spike dropseed, spike muhly, and mountain muhly. Fringed sage, Louisiana sage, common sage, wild tarragon, broom snakeweed, and a low-growing form of rubber rabbitbrush are locally abundant throughout the site. Valley floors and seeps on adjacent slopes support various wetland communities ranging from sedges, rushes, or cattails to narrow ribbons of riparian trees, particularly plains cottonwoods and peachleaf willows. Leadplant and sandbar willows may form extensive clumps along stream channels. Snowberry and prickly rose are locally abundant adjacent to the riparian zone; wild plum, chokecherry, hawthorn, and golden currant may also occur in these sites. Sideslopes of the deeper ravines also contain most of these shrub species, as well as skunkbrush sumac and mountain ninebark, two species more characteristic of the lower foothills.

Effects of past DOE and agricultural land use practices are apparent in some sections of RFP. Weedy forbs, cheatgrass, and bottlebrush squirreltail are locally prominent in disturbed sites. Introduced pasture grasses, including smooth brome, intermediate wheatgrass, and crested wheatgrass, are present in areas where disturbed land has been reclaimed or native range was either "improved" or converted to hay production. Yucca and cacti are abundant on sites with shallow, rocky soils. Individuals or small clumps of ponderosa pine occur on some rock outcrops in western and northern portions of the site.

Plant communities are a dominant factor in determining suitability and quality of wildlife habitat types. The dominant plant community in the OU1 ecology study area is the native mesic grassland type. However, much of the area around the OU1 IHSSs is characterized as reclaimed grassland (Figure E2-2). Relative distribution of the reference area plant communities is depicted in Figure E2-3. Plant communities (habitat types) in the OU1 study area and reference area are described in the following subsections. Data are summarized in Table E2-1 and E2-2. Detailed data are provided in Attachment E-2. Scientific names of plant species cited are listed in Attachment E-5.

E2.2.1.1 Mesic Grassland

Mesic grassland is the most extensive native habitat type within OU1. This diverse plant community occurs in a wide range of topographic positions, including north-facing and south-facing terrace slopes, valley floors, and broad uplands. Differences in slope, aspect, soil, and history of use are reflected in differences in dominance of the various grasses and forbs characterizing the type.

Richness in belt transects within this type totaled 118 species for all transects combined and averaged 45 species (Table E2-1). This mean richness included 13.6 graminoids (grasses and grass-like plants) and 30.1 forbs (broadleaf herbs, including both wildflowers and weeds). Mean diversity (Shannon-Weaver index) was 1.8, the highest value in the study area. The high diversity results both from a relatively large number of species and the lack of extreme dominance by one or a few species.

Basal cover in OU1 mesic grassland averaged 29 percent; graminoids provided 23.7 percent basal cover (83 percent of the total). The balance of the basal plant cover was provided almost entirely by forbs; cover by cacti was 0.2 percent. Most of the ground surface (65.3 percent) was covered by litter (dead remains of previous years' growth). Only 5.2 percent of the ground surface was rock or bare soil (Table E2-2).

Western wheatgrass was the dominant species along cover transects, contributing 30 percent of the total; blue grama was second with 18 percent. Other species included Kentucky bluegrass (8 percent), narrowleaf sedge (6 percent), cheatgrass (5 percent), and side-oats grama (4 percent). The greatest amount of basal cover contributed by a forb was 0.9 percent by hairy golden-aster. The low plant cover values reflect the use of basal cover, which measures the area covered by a plant at the point where it emerges from the ground, rather than the area covered by its foliage.

Mean production in the OU1 mesic grassland was 180 grams per square meter (g/m^2), of which 61 percent (110.5 g/m^2) was provided by graminoids. Over one-fourth of the total production (52.3 g/m^2) was contributed by western wheatgrass. Other major contributors to production

(g/m^2 shown in parentheses) included side-oats grama (13.2), blue grama (13.0), and red three-awn (8.9). Production by forbs (in g/m^2) was dominated by prairie sage (8.3), which is a low-growing but abundant native plant, and two large weed species, musk thistle (8.5) and great mullein (6.0). Broom snakeweed, which may be considered a subshrub, was clipped when it occurred in the production plots and averaged 7.8 g/m^2.

E2.2.1.2 Xeric Grassland

The xeric grassland type, although extensive on a sitewide basis, was very limited in OU1. Across most of RFP, xeric grassland occurs atop the narrow ridges dividing the east-draining streams. Dominant plants typically include species adapted to drier environments and rockier substrates. Most of the suitable ridgetop terrain within OU1 has either been disturbed or replaced by buildings, roads, or other structures. The limited areal extent of this type in OU1 contributed to the low combined richness (38 species), mean richness of 23 species, and diversity (1.1). The mean richness included 8.0 graminoids and 14.9 forbs.

Mean basal cover was 20 percent; 18.1 percent cover (91 percent of the total) was contributed by grasses. Red three-awn was the dominant plant, with 62 percent of the total cover. Other major contributors were smooth brome, cheatgrass, and crested wheatgrass, which added 15, 10, and 3 percent of the total, respectively. Of these, smooth brome and crested wheatgrass are introduced pasture grasses, while cheatgrass is a non-native weedy annual. The major forb in terms of basal cover was curlycup gumweed, a native species that colonizes disturbed areas. An average of 50.4 percent of the ground surface was covered by litter, followed by rock (24.6 percent) and bare soil (5.4 percent).

Production averaged 130 g/m^2 for the xeric grassland; this relatively low value undoubtedly reflects the dry conditions that give this type its name. Nearly two-thirds (66 percent) of the total was contributed by graminoids (85.6 g/m^2). The dominant plant was smooth brome (45.2 g/m^2), followed by red three-awn (21.3 g/m^2) and crested wheatgrass (12.7 g/m^2). The second most important native grass (after red three-awn) was spike dropseed (3.3 g/m^2). Major forbs in terms of production were curlycup gumweed (27.9 g/m^2) and great mullein (7.9 g/m^2). Gumweed is a weedy native species; great mullein is a robust introduced weed.

The prevalence of introduced or weedy species in the OU1 xeric grassland is consistent with its history of disturbance. The prominence of smooth brome and crested wheatgrass may reflect either prior attempts to improve degraded rangeland or invasion from nearby reclaimed sites. The dominant native grass, red three-awn, is relatively unpalatable to livestock and often predominates in overgrazed grasslands.

E2.2.1.3 Marshland

This broad community type includes species characteristic of both tall marshes (cattails and bulrushes) and short marshes (rushes and sedges) and has been variously referred to in other documents as the hydric or aquatic habitat type. Marshland communities occur around seeps, where the shallow water table intersects hillsides, and along streams, ditches, and ponds. The combined richness in OU1 marshland was 55 species, mean richness was 18, and mean diversity was 0.9. These low values reflect the fact that some marsh sites were nearly monotypic (one-species) stands.

Mean basal cover was 16 percent. Graminoids provided 89 percent of the plant cover. The most abundant species were broadleaf cattail and narrowleaf cattail, with cover values of 4.9 and 4.7 percent, respectively. Together, these two species contributed 57 percent of the total plant cover. The other major graminoid was Canada bluegrass, which contributed 3.7 percent basal cover. The prevalent forbs were western ragweed, Canada thistle, and American brooklime, with 0.6, 0.4, and 0.3 percent cover, respectively. Most of the ground surface was covered by litter, which averaged 65.3 percent; rocks were scarce.

Production in the marshland habitat type averaged 387 g/m^2, the greatest amount in the OU1 study area. Graminoids provided 86 percent of this total. Both the large total production and extreme dominance by graminoids reflects the prevalence of cattail species, which provided 63 percent of total production (narrowleaf cattail–127.4 g/m^2; broadleaf cattail–115.9 g/m^2). These two large species were present in 43 percent and 33 percent of the plots, respectively. Major grasses (in g/m^2) were Canada bluegrass (31.8), western wheatgrass (17.7), prairie dropseed (8.8), orchard grass (7.1), foxtail barley (6.3), and Kentucky bluegrass (6.1). The major forb was Canada thistle, which averaged 43.0 g/m^2, or more than 80 percent of the total for forbs (53.5 g/m^2). The second most prevalent forb was western ragweed, which added only 2.5 g/m^2.

E2.2.1.4 Riparian Complex

Areas along Woman Creek typically were dominated by hydrophytic shrubs, with varying numbers of trees and other mesophytes. In grassland habitats such as Rocky Flats, riparian trees are important habitat components for a variety of animal species and can strongly influence vegetation in the understory and the quality of adjacent aquatic habitats.

Combined richness in the riparian woodland along Woman Creek in OU1 was 147; mean richness was 51.0. Both of these values, which were the highest in the study area, reflect the presence of well-developed tree and shrub strata in addition to an herbaceous understory. The diversity value of 1.7 was the second highest, behind mesic grassland.

Trees and tall shrubs provided a significant overstory (63.9 percent canopy cover) along the riparian complex cover transects. Plains cottonwood was heavily dominant in the tree layer, composing 58 percent of the total. Peachleaf willow, narrowleaf cottonwood, and white poplar provided 16, 14, and 12 percent of the tree canopy, respectively. Within the shrub stratum, the two major species were sandbar willow and leadplant, with 19.8 and 18.4 percent cover (45 and 42 percent of the total), respectively. Two low shrubs, western snowberry and prickly rose, were also common components of the understory, particularly outside the tree canopy.

Basal herbaceous cover averaged 21.6 percent in this habitat type. Graminoids provided 15.8 percent mean cover (73 percent of the total). Dominant species were Kentucky bluegrass, Canada bluegrass, and smooth brome, with 14, 13, and 5 percent of the total, respectively. The dominant forb was Canada thistle, which contributed one-fourth of the 2.3 percent total cover by forbs. Litter added 57.9 percent cover.

Mean herbaceous production was 106 g/m^2, of which 85 percent was provided by graminoids. The fact that this was the lowest value in the study area probably resulted from shading and competition by woody species. Dominant graminoids in terms of production (g/m^2) were smooth brome (34.2), broadleaf cattail (27.7), Nebraska sedge (7.9), Kentucky bluegrass (6.8), and Baltic rush (5.8); the major forb was Canada thistle (7.7). The high production values for the cattail and thistle resulted primarily from the large size of individual plants and thus somewhat exaggerate their spatial dominance.

E2.2.1.5 Reclaimed Grassland

This habitat type consisted primarily of introduced pasture grasses planted at some time in the past to rehabilitate degraded or denuded areas and occurred in various forms depending on the plant species used to revegetate. This type occupies much of the area around the OU1 IHSSs but did not occur in the Rock Creek reference area.

A total of 81 species occurred in the reclaimed grassland in OU1; the mean richness of transects in this area was 23. However, diversity was low in this area, and only a small number of species were present above trace amounts. Basal cover in the OU1 reclaimed grassland averaged 20 percent. As would be expected, grasses comprised the overwhelming majority (93 percent) of cover along the transects. Smooth brome contributed nearly half (47 percent) of the total. Another introduced reclamation species, intermediate wheatgrass, was second with 12 percent of the total. Little bluestem and western wheatgrass were the third and fourth dominant grasses, followed by crested wheatgrass, big bluestem, and red three-awn. Smooth brome was hit along 90 percent of the cover transects, while intermediate wheatgrass and little bluestem were each hit along only 40 percent.

Mean production in the reclaimed grassland habitat was 191 g/m^2, of which 97 percent was provided by grasses. Smooth brome comprised the majority of production with an average of 118.0 g/m^2 or 62 percent of the total. Smooth brome occurred in 100 percent of the production plots and was the only grass present in more than half of the plots. Other plots in OU1 exhibited a codominance of smooth brome with either intermediate wheatgrass (30 g/m^2) or western wheatgrass (21.1 g/m^2). These mixed plots also included a minor component of other grasses (including the natives green needlegrass, Kentucky bluegrass, and tumble-grass) and a larger variety of weedy forbs (field bindweed, a strongly invasic forb, was the only species clipped in the smooth brome monocultures). These cover and production patterns suggest two seed mixes may have been used for reclamation: a smooth brome monoculture on the most disturbed area (to guarantee soil stability), and a wheatgrass/brome mixture in less disturbed areas. Smooth brome is known for maintaining a monoculture, but when planted as a mixture, is less likely to establish complete dominance. In addition, less disturbed soil may have retained some components of the native vegetation.

E2.2.1.6 Disturbed Land

Some areas of OU1, as well as other parts of the industrial complex at RFP, show evidence of severe prior disturbance. The disturbed land is typified by an abundance of weedy forbs and relatively little native vegetation. Combined richness along belt transects was 68 species; mean richness was 23.3 species. Almost all of the plants present were non-native annuals or biennials.

Basal cover was 15.1 percent, with graminoids providing only 9.9 percent (66 percent of the total). Forbs provided all of the remaining plant cover. Cover by litter was 47.9 percent; bare soil and rock were 3.0 and 6.7 percent of the ground surface, respectively. The low basal cover and high bare soil values reflect the dominance by weedy forbs, which typically arise as a single stem (often from a tap root) and may blow away during the winter instead of adding to the litter layer. The only other habitat type in the study area with a comparably low cover by litter was the xeric grassland, which also had a significant component of weedy forbs.
Production in the OU1 disturbed land averaged 139.5 g/m^2, mostly contributed by introduced grasses and weedy forbs. Grasses accounted for a mean of 101.5 g/m^2 (73 percent of the total); the fact that the dominant species was smooth brome (83.6 g/m^2) suggests possible failed reclamation. Spike dropseed was clipped in only three plots (10 percent), but a very high value in one of the plots resulted in an average of 4.1 g/m^2. Western wheatgrass, Kentucky bluegrass, and intermediate wheatgrass added 3.4, 3.1, and 2.6 g/m^2, respectively. Forb production averaged 38.0 g/m^2. The three dominant forbs were yellow sweetclover, Canada thistle, and knapweed, with mean values of 21.4, 7.3, and 3.9 g/m^2, respectively.

E2.2.2 Wildlife

As in most of the Front Range Urban Corridor, the wildlife of Rocky Flats has been greatly influenced by the increase in human activity and disturbance over the past 100 years. Most notable have been reductions in the number and diversity of ungulates (hoofed animals) and predators. However, the relative isolation and habitat diversity of Rocky Flats have resulted in a fairly rich animal community. Scientific names of vertebrate species referenced in the following discussions are listed in Attachment E-5.

The Rocky Flats Environmental Impact Statement (EIS)(DOE, 1980a) reported that eight species of small mammals were captured during a live-trapping program in 1975. These species were listed as the deer mouse, harvest mouse, meadow vole, thirteen-lined ground squirrel, northern pocket gopher, hispid pocket mouse, silky pocket mouse, and house mouse. More recent studies have documented the occurrence of Mexican woodrats, prairie voles, western jumping mice, and meadow jumping mice and demonstrated that both the plains harvest mouse and western harvest mouse are present. White-tailed jackrabbits, black-tailed jackrabbits, and desert cottontails are also present on the site. The most abundant large mammal is the mule deer, with an estimated population of more than 170. White-tailed deer also occur, but in low numbers. Carnivores present include coyotes, red foxes, gray foxes, bobcats, raccoons, badgers, long-tailed weasels, and striped skunks.

Common grassland birds at RFP during the breeding season include western meadowlarks, horned larks, vesper sparrows, grasshopper sparrows, and both western and eastern kingbirds. Wetlands support song sparrows, common yellowthroats, red-winged blackbirds, common snipe, and sora rails. Black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, blue grosbeaks, and lesser and American goldfinches (among other species) nest in cottonwoods. Wooded draws attract foothills species, including MacGillivray's warblers, yellow-breasted chats, black-headed grosbeaks, green-tailed and rufous-sided towhees, and lazuli buntings. Prevalent species during the winter include horned larks in grasslands, pine siskins in riparian trees, and dark-eyed juncos in brushy habitats.

Common birds of prey in the area include American kestrels, northern harriers, red-tailed hawks, Swainson's hawks, great horned owls, and long-eared owls. Golden eagles, ferruginous hawks and prairie falcons also occur, as do rough-legged hawks, short-eared owls, and occasional bald eagles during the winter and migration seasons.

The most abundant reptiles at RFP are the bullsnake, yellow-bellied racer, western terrestrial gartersnake, and prairie rattlesnake.

Surface waters at RFP support a variety of aquatic macroinvertebrates, including snails and several orders of insects and crustaceans. Some of the ponds and stream reaches are inhabited by fathead minnows, creek chubs, golden shiners, and green sunfish. Largemouth bass occur in some ponds. The ponds also attract water birds such as mallards, gadwall, green-winged and blue-winged teal, pied-billed grebes, spotted sandpipers, killdeer, great blue herons, black-crowned night-herons, and double-crested cormorants. Muskrats and western painted turtles occur in some of the ponds. In addition, the ponds and creeks provide feeding habitat and water sources for various terrestrial species and breeding habitat for amphibians. Leopard frogs, Woodhouse's toads, northern chorus frogs, and tiger salamanders have been observed at RFP.

Results of community ecology studies for small mammals, terrestrial arthropods, fishes, and benthic macroinvertebrates are summarized in the following subsections.

E2.2.2.1 Small Mammals

Deer mice and meadow voles were the dominant species in all habitats of OU1 and the reference areas during spring and fall 1991 (Table E2-3). Also captured in OU1 were plains harvest mice in mesic grassland and marshland; hispid pocket mice in marshland and disturbed land; prairie voles in disturbed land; and a single Preble's meadow jumping mouse in reclaimed grassland. The presence of this jumping mouse is especially important because of its special status (see E2.2.3). Results of spring and fall sampling were similar (Table E2-3). Data for spring sampling are discussed below.

The deer mouse was most strongly dominant in disturbed land, where it comprised 88 percent of the total captures, and least dominant (54 percent) in reclaimed grassland. The most productive small mammal habitats in terms of mean number of captures per 100 trap-nights were marshland (39.3) and disturbed land (32.5). Reclaimed and riparian habitat were intermediate (20.9 and 15.3, respectively), while mesic grassland and xeric grassland were low (5.7 and 0.0). The high value for marshland included both the greatest number of meadow voles and the second greatest number of deer mice, probably as a result of the fact that plant biomass in marshland was the highest in the study area. Voles feed primarily on plant foliage and are attracted to lush, moist sites. Deer mice feed on seeds and foliage and are found in moist and dry sites.

The abundance of small mammals in the disturbed habitat may seem surprising, but it should be remembered that annual and biennial weeds, which dominated this type, produce copious quantities of seeds. Most of the mice captured in disturbed land were deer mice, which feed heavily on seeds as well as other plant parts and invertebrates. Hispid pocket mice, which also were captured in this habitat type, feed primarily on seeds.

The low numbers for mesic and xeric grassland were unexpected, given the relatively high plant cover, richness, and production data described above (Section E2.2.1). The two native grassland types were also the least productive habitats in the reference area, although the differences were not as pronounced (see Section E7.2.1.2). Rockier soils in these two habitat types, particularly xeric grassland on cobbly ridgetops, may limit the ability of small mammals to find suitable burrow (den) sites.

E2.2.2.2 Terrestrial Arthropods

Sweep-netting was the primary method used to survey the terrestrial arthropod communities in the study area and reference area and provided much more data (in terms of organisms captured) than either pitfall trapping or opportunistic netting. The four classes of arthropods captured were Diplopoda (millipedes), Crustacea (isopods or pill bugs), Arachnida (spiders and allies), and Insecta (insects). Of these, insects were the most abundant and taxonomically diverse group.

In the OU1 study area, leafhoppers (Homoptera: Cicadellidae) were the most abundant arthropods, comprising 26.7 percent of total captures. True spiders (Hydracarina: Araneae) were the second most abundant arthropod group, contributing 10.1 percent of the total. Other abundant groups in terms of percent of total captures included the following insect families: grasshoppers (Orthoptera: Acrididae)–8.7; ants (Hymenoptera: Formicidae)–6.9; seed bugs (Hemiptera: Lygaeidae)–3.4; leaf beetles (Coleoptera: Chrysomelidae)–3.2; spittle bugs (Homoptera: Cercopidae)–2.9; leaf bugs (Hemiptera: Miridae)–2.4; ladybird beetles (Coloeptera: Coccinellidae)–2.3; and treehoppers (Homoptera: Membracidae)–2.0. All of these groups are herbivorous, except for ants, which are omnivorous, and spiders and ladybird beetles, which are predacious.

Results of the sweep-netting survey are summarized below by habitat type. Table E2-4 shows the number of captures for the most abundant families in the OU1 study area.

Mesic Grassland

Leafhoppers were numerically dominant in the study area, followed by spiders. This habitat type was intermediate in both number of families (46) and number of individuals (583). This finding is consistent with the fact that mesic grassland was also intermediate in terms of vegetational characteristics (see Section E2.2.1).

Xeric Grassland

This habitat type had the lowest number of families (23) and individuals (106) in OU1, probably because of the drier conditions and prevalence of shorter plant species. Leafhoppers were again numerically dominant, followed by spiders.

Marshland

Sampling in this habitat type produced both a greater number of arthropod families (65) and total individuals (670) than either of the grassland types. This probably is related to a combination of the higher plant cover and production and greater moisture. Spiders and grasshoppers were the most abundant groups.

Riparian Complex

This horizontally and vertically complex habitat type shared with marshland the highest number of families (65) and yielded by far the largest number of individuals (1,111). The prevalence of woody species and taller herbaceous species than in the other habitats, along with the increased lushness associated with the ample moisture, were probably the principal factors contributing to this result. Leafhoppers were the most abundant group, followed by ants and spiders.

E2.2.2.3 Benthic Macroinvertebrates

The benthic macroinvertebrate community of Woman Creek adjacent to OU1 was strongly influenced by low and nonpersistent flows at stream sites and, in Pond C-1, by the generally fine-textured sediment. As shown in Tables E2-5 (for spring and fall sampling seasons, respectively), the benthic macroinvertebrate communities within the creek were generally dominated by insect larvae of the orders Diptera (true flies) and Ephemeroptera (mayflies).

During the spring, dipterans contributed 18 to 79 percent (mean = 62 percent) of the total individuals at the four streams sites. Mayflies were second, adding 3 to 37 percent (mean = 18 percent). During fall sampling, mayflies represented 27 to 57 percent (mean = 42 percent) of the total benthic macroinvertebrates in the four stream stations. Dipterans were second, contributing 17 to 47 percent (mean = 31 percent of the total).

Pond C-1 differed from the stream sites in that oligochaetes were the dominant macroinvertebrates in the fine substrate. Oligochaetes contributed 63 percent of the total individuals in spring and 62 percent in fall. Dipterans were the only other group present in detectable numbers within the sediment samples from Pond C-1.

Results of macroinvertebrate sampling and basic water quality evaluations at the four stream sites and Pond C-1 are summarized below. Descriptions of the stream sites are presented from the most upstream to the most downstream station.

Stream Site SW039

This site was located upgradient of OU1 and just below the confluence of the two main forks of Woman Creek. During the spring (early summer) sampling, water temperature was 15 degrees Celsius (°C), dissolved oxygen was 8.8 milligrams per liter (mg/L), pH was 7.8, and total hardness was 99.0 mg/L. All of these values are within normal ranges. Values for nutrients were also normal; concentrations of nitrate nitrogen and orthophosphates were 0.8 and 0.48 mg/L, respectively. Ammonia, a source of nitrogen that can be toxic at high concentrations, was 0.23 mg/L, which is well below toxic thresholds. During the fall sampling, lower temperature (7.5°C) resulted in higher dissolved oxygen (10.5 mg/L). The pH was the same as in spring (7.8), while total hardness was lower (79.0 mg/L). Nitrate nitrogen and orthophosphate levels were higher, at 1.6 and 4.7 mg/L, respectively. However, ammonia nitrogen levels were very similar to spring (0.25 mg/L) and well below toxic levels.

Site SW039 yielded the highest total number of individuals per sample (147) of the four stream sites. True flies and mayflies contributed 72 and 22 percent of the total organisms, respectively. The most abundant dipterans were black flies (*Simulium* sp.) and midges (*Orthocladius* sp.), each of which contributed 29 percent of the total organisms. The dominant mayfly was *Baetis tricaudatus*.

In fall, SW039 contained an average of only 106 individuals per sample, the second lowest value. Dipterans and ephemeropterans again dominated, with 32 and 53 percent of the total. The most abundant taxa were the mayfly *Caenis* sp. and the midge *Tanytarsus* sp., which represented 45 and 23 percent of the total, respectively.

Stream Site SW033

This site was located just slightly upgradient of OU1 a short distance above the confluence with a minor tributary entering Woman Creek from the south. Physicochemical characteristics (shown as spring/fall data) were as follows: temperature–15.0/6.5°C; dissolved oxygen–9.2/9.7 mg/L; pH–8.00/8.04; total hardness–141/158 mg/L; nitrate nitrogen–0.5/1.7 mg/L; orthophosphate–0.36/4.8 mg/L; and ammonia nitrogen–0.21/0.43 mg/L.

The benthic macroinvertebrate community in the spring produced the second greatest number of individuals (130). The samples were heavily dominated by dipterans, which contributed 79 percent of the total). The major contributors were midges in the genera *Orthocladius* and *Cricotopus* (= *Isocladius*), with 67 and 16 percent of the total, respectively. The mayfly *Baetis tricaudatus* added another 10 percent.

In the fall, SW033 produced a mean of 451 organisms per sample, by far the greatest number. This high density was the result of very large numbers of ephemeropterans (257 per sample, or 57 percent of the total). The two most abundant taxa were the mayflies *Caenis* sp. and *Tricorythodes minutus*, with 37 and 17 percent, respectively. Other common taxa included blackflies (*Simulium* sp.)–36 percent, the caddisfly *Hydropsyche alhedra*–34 percent, the snail *Physella* sp.–25 percent, and predatory damselfly nymphs of the genus *Argia*.

Stream Site WORI3

This station represented the reach of Woman Creek below OU1 and above Pond C-1. Water quality parameters, which were measured only during the fall sampling, were generally comparable to the previous two sites. The relatively low water temperature of 6.0°C corresponded to a relatively high dissolved oxygen value of 10.5 mg/L. Total hardness was 156 mg/L, and pH was 8.09. Nutrient values were relatively high, with nitrate nitrogen and orthophosphate concentrations of 2.30 and 5.00 mg/L, respectively. Ammonia nitrogen was 0.27 mg/L.

This was the only Woman Creek stream site sampled during the OU1 EE at which mayflies outnumbered true flies during the spring (37 versus 18 percent of the total). This resulted from the very low number of dipterans (16 per sample), which also led to the smallest total number of macroinvertebrates (89). The most abundant macroinvertebrates were aquatic earthworms, which contributed 21 percent of the total. Other prevalent taxa included the mayfly *Baetis tricaudatus*, which contributed 11 percent of the total, and the amphipod *Hyalella azteca*, which added 7 percent. *Caenis* mayflies, damselflies (*Enallagma* sp.), and craneflies (*Tipula* sp.) each contributed 6 percent of the total number of organisms per sample.

In the fall, this site was again the least productive, with an average of only 55 organisms per sample. As in spring, oligochaete worms were the most abundant group, with 35 percent of the total, and mayflies outnumbered true flies by approximately two to one (29 versus 15 percent, respectively). The second most abundant taxon was the mayfly genus *Caenis* (24 percent), followed by unidentifiable chironomid midges (13 percent).

Stream Site WORI1

This site was located downstream of Pond C-1. During the spring, water temperature was relatively high (17°C), and dissolved oxygen was consequently lower (7.8 mg/L) than the other sites. Total hardness (150 mg/L) and pH (7.90) were similar to the more upstream stations, as were nitrate nitrogen (0.6 mg/L), orthophosphate (0.64 mg/L), and ammonia nitrogen (0.36 mg/L). This site also had the highest temperature (10°C) and lowest dissolved oxygen (8.8 mg/L) in the fall. Total hardness in the fall was relatively high (190 mg/L); pH was 8.06. Nutrient values (in mg/L) were 0.8 for nitrate nitrogen, 4.90 for orthophosphate, and 0.26 for ammonia nitrogen.

The mean number of benthic macroinvertebrates per sample during the spring (106) was approximately average for the four stream sites. Dipteran larvae accounted for 77 percent of the total, followed by caddisflies (Trichoptera) with 13 percent. The most abundant taxa were the mayfly *Baetis quilleri* (21 percent), the midge *Orthocladius* sp. (18 percent), and the blackfly *Simulium* sp. (15 percent).

The total number of organisms in the fall (226) was the second highest and resulted primarily from the largest number of dipterans. This group, which contributed 47 percent of the total, was dominated by midges of the genus *Thienemannimyia* (16 percent), *Orthocladius* (9 percent), and *Cricotopus* (8 percent). However, the most abundant organisms were *Caenis* mayflies (17 percent). Mayflies in the genus *Paraleptophlebia* added another 7 percent of the total. Other common macroinvertebrates included the amphipod *Hyalella azteca* (8 percent), the snail *Physella* sp. (6 percent), and the damselfly *Argia* sp. (6 percent).

Pond Site SW0C1 (Pond C-1)

Of all the retention ponds at RFP, this is one of the most natural in appearance because of the adjacent vegetation that has developed. The primary reason for the maturity of this pond is the fact that water levels are relatively stable, unlike most of the A-series and B-series ponds.

During the spring sampling, Pond C-1 had a water temperature of 19°C and a dissolved oxygen level of 8.2 mg/L. Total hardness was moderate at 141 mg/L. Nitrate nitrogen, orthophosphate, and ammonia nitrogen were 0.9, 0.88, and 0.38 mg/L, respectively, all of which were within normal ranges and essentially the same as the water within the creek. In fall, the cooler water temperature (10°C) led to a higher concentration of dissolved oxygen (10.6 mg/L). Total hardness was higher (180 mg/L), as was orthophosphate (4.80 mg/L). Values for nitrate nitrogen (0.8 mg/L) and ammonia nitrogen (0.40 mg/L) were comparable to those during the spring.

Only two groups of benthic macroinvertebrates were present in sediment samples collected during the spring: oligochaetes (64 percent) and dipteran larvae (36 percent). The most abundant Diptera were the midges *Procladius* sp. (20 percent) and *Tanypus* sp. (11 percent). Three other midge taxa comprised the remainder of the total. The small number of taxa (6) and individuals (66) led to a low diversity value of 1.61.

The benthic community in fall was much richer, with a total of 10 taxa, although these were again limited to oligochaetes and dipterans. The mean total number of individuals per sample (503) was greater than any of the four stream sites. Aquatic earthworms were again strongly dominant, contributing 62 percent of the total. Among dipterans, midges in the genus *Chironomus* were by far the most numerous, with a mean of 133 per sample (26 percent) and a maximum of 1,139 (49 percent of the total for that individual sample). *Tanypus* and *Procladius* midges added 4 percent and 3 percent, respectively. Although the numbers and individuals and taxa were higher than in spring, the extreme dominance by only two taxa resulted in a lower diversity value (1.45).

<u>South Interceptor Ditch and Pond C-2</u>

The SID provided limited aquatic habitat, primarily areas of cattails. However, nonpersistent flows made the ditch unsuitable for colonization by benthic macroinvertebrates. In contrast, Pond C-2 (SW0C2) supported a diverse benthic community, based on results of sampling in spring (this site was not sampled in fall). Mean number of individuals per sample (118) was comparable to most of the stream sites on Woman Creek (which had a mean of 127 in spring) and approximately twice that of Pond C-1 (67). Seventeen taxa were present within the sediment samples from Pond C-2, although two taxa—oligochaete worms (36 percent) and *Chironomus* midges (28 percent)—were by far the most abundant. Other significant contributors to the total were the midges *Tanypus* sp. and *Procladius* sp. and the phantom midge *Chaoborus albipes*. Shannon-Weaver diversity was 2.76.

E2.2.2.4 Fish

As with benthic macroinvertebrates (see previous section), low and intermittent flows along most stretches of Woman Creek greatly limit its ichthyofauna. As shown in Table E2-6, the two stream sites on Woman Creek above Pond C-1 (SW033 and WORI3) supported only two fish species, both of which are members of the minnow family: the creek chub, found at both stations, and the stoneroller, captured only at the downstream station. Within its range, "the creek chub may be found in almost any stream capable of supporting fish life" (McClane, 1978), being able to tolerate a wide range of water and habitat conditions. It feeds on a variety of small insect prey. The stoneroller is found in small streams of moderate gradient and sandy-gravel substrates. It is primarily a bottom-feeder, consuming insect larvae, small crustaceans, and algae.

Species present in the reach of Woman Creek sampled below Pond C-1 (WORI1) were the fathead minnow and largemouth bass, the latter occurring as juvenile fish. The fathead minnow, like the creek chub, is widespread within its range but may inhabit ponds as well as streams with silty bottoms. Fathead minnows feed primarily on plankton. Food of juvenile largemouth bass includes a variety of insects, crustaceans, and fish small enough to be consumed.

Sampling at Pond C-1 (SW0C1) yielded seven species: the stoneroller, creek chub, fathead minnow, golden shiner, white sucker, green sunfish, and largemouth bass. Of these, the golden shiner was the most abundant. This species prefers relatively clear, weedy ponds and quiet streams and may occur in large schools (McClane, 1978). Golden shiners feed on aquatic insects, small mollusks, and algae and may themselves be an important prey species for larger fish or piscivorous birds because of their larger numbers and size relative to most other minnow species. White suckers are "tolerant of large amounts of pollution, siltation, and turbidity and . . . able to survive in waters low in oxygen" (McClane, 1978). This widespread species feeds on insect larvae, other benthic macroinvertebrates, and algae. Green sunfish are also able to tolerate a wide range of water quality and habitat conditions. Prey includes a variety of nektonic (free-swimming) insects, crustaceans, and small fishes. Largemouth bass in Pond C-1 included some large individuals that undoubtedly represented the top of the aquatic food web.

The fish communities in Woman Creek and Pond C-1 were typical for small streams in similar topographic and ecological settings in the region. Species present are generally able to withstand low flows because of their tolerance of warm temperatures. The Woman Creek ecosystem apparently provides sufficient conditions of food, cover, and water quality to maintain a limited warm-water fish community.

The SID also provides some aquatic habitat. The SID collects surface and shallow subsurface flows from the hillside south of Woman Creek and carries the water into Pond C-2, which is isolated from Woman Creek itself. No fish were captured in the SID. The muddy substrate and very low flows afford poor habitat for fish; physical barriers would probably impede colonization from Pond C-2, even if habitat were more suitable. Pond C-2 (SW0C2) supported a very limited ichthyofauna. The only species captured was the fathead minnow, which was present in very large numbers owing to the absence of a predatory fish.

E2.2.3 Sensitive Habitats and Endangered Species

Federally listed endangered species potentially of interest in the Rocky Flats area are the black-footed ferret, peregrine falcon, and bald eagle (ASI, 1991). Black-footed ferrets are not known to occur in the vicinity of RFP. Critical habitat for the black-footed ferrets consists primarily of colonies of its major food item, the prairie dog. Prairie dogs occur in only small numbers on or near RFP. Bald eagles occur occasionally in the RFP area, primarily as winter vagrants or migrants. No roost areas or nest sites exist at RFP, although a pair exhibited nesting behavior in an area of cottonwoods east of RFP in 1993. The pair did not successfully breed. Pre-migration courtship and nest construction behavior by wintering bald eagles is common. Peregrine falcons may occur as migrants, and a pair nested approximately 10 kilometers to the northwest in both 1991 and 1992. Two pairs nested in the same general area in 1994. It is possible that the hunting territory of nesting peregrines could include Rocky Flats, although suitable habitat occurs closer to the nest area.

Three "Category 2" species have been documented to occur at RFP: the ferruginous hawk, long-billed curlew, and Preble's meadow jumping mouse. Ferruginous hawks have been observed throughout the year and appear to be vagrants. The species may nest near RFP and use the site for hunting. Potential nest sites in the vicinity of RFP include scattered trees and rocky ridgetops. Long-billed curlews are grassland birds, in the sandpiper family. A long-billed curlew was reported at RFP during the fall migration of 1993.

Preble's meadow jumping mice were captured in small numbers along Woman Creek in 1991, and one individual was captured in reclaimed grassland within the OU1 study area. As a result of the discovery of Preble's jumping mouse at RFP, an intensive survey for the species was undertaken in 1992 (EG&G, 1992a) and repeated in 1993. Surveys were conducted during the summer, because jumping mice become inactive by early fall. The 1992 program resulted in live captures of 10 Preble's jumping mice, including 2 along Woman Creek below Pond C-1. The areas where Preble's jumping mice were captured were dominated by shrubs, such as sandbar willow, leadplant, and western snowberry, with relatively lush grasses and forbs. The status of this species in Colorado and especially at Rocky Flats is discussed further in Section E9.

Other Category 2 wildlife species potentially present at RFP include the white-faced ibis, mountain plover and swift fox (ASI, 1991). To date, these species have not been documented at RFP.

Four plant species of special concern reported by ASI (1991) as potentially present include one threatened species (Ute lady's tresses), one Category 2 species (Colorado butterfly plant), and two species of concern in Colorado (forktip three-awn; toothcup). None of these species was found at RFP during the ASI (1991) survey. However, the forktip three-awn was reported along Woman Creek in 1973 and was documented in the same area during intensive vegetation investigations of OU5 (Woman Creek) in 1991. The toothcup has been reported from a temporary pool about 4 miles east of Boulder, and the Ute lady's tresses has been reported near Clear Creek to the south of RFP and near South Boulder Creek to the north of RFP (ASI, 1991). The Colorado butterfly plant has not been reported near RFP, but wetlands along the major creeks represent suitable habitat for both this species and the lady's tresses. Neither species was found during surveys of appropriate habitat in 1992 or 1993.

The discovery of large populations of Ute lady's tresses on City of Boulder Open Space only a few miles from RFP led EG&G to initiate a survey for this species in suitable moist habitats in 1992; the survey was repeated and expanded in 1993. Surveys for Ute lady's tresses are performed during late summer, when the plant is most easily detected and identified by its spike of small, white flowers. Ute lady's tresses were not observed at Rocky Flats during the 1992 survey (EG&G, 1992b). The report concluded that some sites at RFP contained the appropriate degree of moisture, based on the presence of commonly associated plant species, such as blue vervain, great lobelia, and swamp milkweed.

Several wetlands identified at RFP come under the protection of state and federal laws (EG&G, 1990). Wetlands at RFP were identified in conjunction with the National Wetlands Inventory (FWS, 1979) and field checked by U.S. Army Corp of Engineers personnel to verify their jurisdictional status. These wetlands consist of emergent, intermittently flooded stream channels and artificial, semipermanent ponds. Wetlands along drainages in most areas of RFP are dominated by a narrow band of cattails, leadplant, or sandbar willows with emergent trees and mesophytic or hydrophytic grasses and forbs. Prominent riparian trees include plains cottonwoods, lanceleaf (hybrid plains and narrowleaf) cottonwoods, white poplars, and peachleaf willows; Siberian elms and Russian-olives are also common. Many of the same woody and herbaceous species occur along margins of ponds, particularly those with more stable water levels such as Pond C-1.

Table E2-1

Plant Community Parameters in OU1 Study Area[a]

Community Type/Parameters	Mean Values
Mesic Grassland	
Cover	29
Richness	45
Diversity	1.8
Production	180
Tree, Shrub, And Yucca Density	0
Cactus Density	8.5
Xeric Grassland	
Cover	20
Richness	23
Diversity	1.1
Production	130
Tree, Shrub, and Yucca Density	0
Cactus Density	0
Marshland	
Cover	16
Richness	18
Diversity[b]	0.9
Production	387
Tree, Shrub, and Yucca Density	5.7
Cactus Density	0
Riparian Complex	
Cover	22
Richness	51
Diversity[b]	1.7
Production	106
Tree, Shrub, and Yucca Density	455
Cactus Density	4.4
Reclaimed Grassland	
Cover	20
Richness	23
Diversity	1.2
Production	191
Tree, Shrub, and Yucca Density	1.9
Cactus Density	0.3

Table E2-1
(Continued)

Plant Community Parameters in OU1 Study Area

Community Type/Parameters	Mean Values
Disturbed Land	
Cover	15
Richness	23
Diversity[b]	1.6
Production	140
Tree, Shrub, and Yucca Density	4.3
Cactus Density	0.1

[a]Values may differ from detailed data shown in Attachment B because of rounding

[b]n = 10, except for diversity in marshland, disturbed land, and riparian complex areas, where n = 15

Table E2-2

Mean Basal Cover (%) by Life Form and Habitat Type in OU1 Study Area[a]

	HABITAT TYPE					
	Mesic Grassland	Xeric Grassland	Marshland	Riparian Complex	Reclaimed Grassland	Disturbed Land
Sample Size	10	10	15	15	10	15
Life Form						
Graminoids	23.7	18.1	14.5	15.8	18.4	9.9
Forbs	4.9	1.5	1.9	2.3	1.4	5.1
Trees and Shrubs	0	0	0	3.4	0	0
Cacti	0.2	0	0	0.1	0	0
Total Plant Cover	28.8	19.6	16.3	21.6	19.8	15.1
Rock	3.4	24.6	1.3	9.5	2.8	6.7
Bare Soil	1.8	5.4	17.7	5.1	5.2	30.9
Litter	65.3	50.4	65.3	57.9	72.2	47.9

[a]Values may differ from detailed data shown in Attachment B because of rounding

Table E2-3

Relative Abundance of Small Mammals in OU1 Study Area in Spring and Fall 1991[a]

SPECIES[b]	MIOC	MIPE	PEHI	PEMA	REMO	ZAHU	ZAPR	NEME	TOTAL
Spring									
Mesic Grassland	0	1.7	0	3.3	0.7	0	0	0	5.7
Xeric Grassland	0	0	0	0	0	0	0	0	0
Marshland	0	15	0.3	23.5	0.5	0	0	0	39.3
Riparian Woodland	0	4	0	11.3	0	0	0	0	15.3
Reclaimed Grassland	0	9.3	0	11.3	0	0.3	0	0	20.9
Disturbed Land	0.5	2.5	1	28.5	0	0	0	0	32.5
Fall									
Mesic Grassland	0	3.7	0.3	5.5	0	0	0	0	9.5
Xeric Grassland	0	0	0	0	1	0	0	0	1
Marshland	0	15.3	0.5	15	0	0	0	0	30.8
Riparian Woodland	0	10.7	1	12.7	0	0	0	0	24.4
Reclaimed Grassland	0.3	6.7	0.5	9.3	0	0	0	0	16.8
Disturbed Land	0	13.5	0.5	41.5	0	0	0	0.5	56

[a] Relative abundance = number caught per 100 trap nights

[b] MIOC = Prairie vole (*Microtus ochrogaster*)
MIPE = Meadow vole (*Microtus pennsylvanicus*)
PEHI = Hispid pocket mouse (*Perognathus hispidus*)
PEMA = Deer mouse (*Peromyscus maniculatus*)
REMO = Plains harvest mouse (*Reithrodontomys montanus*)
ZAHU = Meadow jumping mouse (*Zapus hudsonius*)
ZAPR = Western jumping mouse (*Zapus princeps*)
NEME = Mexican woodrat (*Neotoma mexicana*)

Table E2-4

Relative Abundance of Terrestrial Arthropods by Taxon in OU1 Study Area and Reference Area

Taxon			Study Area		Reference Area	
Order	**Family**	**Common Name**	**No.**	**%**	**No.**	**%**
Araneae	Unknown	True Spiders	357	10.1	409	8.4
	Subtotal		357	10.1	409	8.4
Coleoptera	Cantharidae	Soldier Beetles	35	1.0	13	0.3
	Chrysomelidae	Leaf Beetles	113	3.2	131	2.7
	Coccinellidae	Ladybird Beatles	80	2.3	122	2.5
	Curculionidae	Weevils	55	1.6	32	0.7
	Other		53	1.5	85	1.7
	Subtotal		336	9.5	383	7.8
Diptera	Agromyzidae	Leaf Miner Flies	49	1.4	49	1.0
	Chironomidae	Midges	34	1.0	13	2.7
	Chloropidae	Eye Gnats	52	1.5	21	0.4
	Other		149	4.2	175	3.6
	Subtotal		284	8.0	258	5.3
Hemiptera	Lygaeidae	Seed Bugs	121	3.4	160	3.3
	Miridae	Leaf Bugs	84	2.4	54	1.1
	Nabidae	Damsel Bugs	64	1.8	40	0.8
	Pentatomidae	Stink Bugs			25	0.5
	Rhopalidae	Boxelder Bugs	60	1.7	63	1.3
	Tingidae	Lace Bugs	41	1.2	7	0.1
	Other		117	3.3	89	1.8
	Subtotal		487	13.8	438	9.0

Table E2-4
(Continued)

Relative Abundance of Terrestrial Arthropods by Taxon in OU1 Study Area and Reference Area

Taxon			Study Area		Reference Area	
Order	**Family**	**Common Name**	**No.**	**%**	**No.**	**%**
Homoptera	Aphididae	Aphids	48	1.4	138	2.8
	Cercopidae	Spittlebugs	102	2.9	115	2.4
	Cicadellidae	Leaf Hoppers	945	26.7	1,679	34.4
	Membracidae	Treehoppers	70	2.0	162	3.3
	Other		70	2.0	26	0.5
	Subtotal		1,235	34.9	2,120	44.4
Hymenoptera	Braconidae	Braconid Wasps	21	0.6	27	0.6
	Chalcididae	Chalcid Wasps	56	1.6	94	1.9
	Formicidae	Ants	245	6.9	715	14.6
	Halictidae	Halictid Wasps	24	0.7	15	0.3
	Other		21	0.6	29	0.6
	Subtotal		367	10.4	880	18.0
Lepidoptera	Geometridae	Geometer Moths	12	0.3	10	0.2
	Noctuidae	Noctuid Moths	16	0.5	6	0.1
	Pyralidae	Pyralid Moths	2	0.0	10	0.2
	Other		26	0.7	65	1.3
	Subtotal		56	15.8	91	1.9
Neuroptera	Chrysopidae	Green Lacewings	26	0.7	21	4.3
	Other		5	0.1	0	0.0
	Subtotal		31	0.9	21	4.3

Table E2-4
(Continued)

Relative Abundance of Terrestrial Arthropods by Taxon in OU1 Study Area and Reference Area

Taxon			Study Area		Reference Area	
Order	**Family**	**Common Name**	**No.**	**%**	**No.**	**%**
Orthoptera	Acrididae	Grasshoppers	308	8.7	163	3.3
	Grylidae	Crickets	43	1.2	83	1.7
	Other		12	0.3	13	0.3
	Subtotal		363	10.3	259	5.3
Other Orders (11)			22	0.6	28	0.6
Total Arthropods			3,538		4,887	

Table E2-5

Mean Benthic Macroinvertebrate Densities, OU1 Surface Water Sites, Woman Creek Drainage, Spring 1991[a]

		Stream Sites[b]				Pond Site
Taxon	Common Name	SW039	SW033	WORI3	WORI1	SWC01
Oligochaeta	Earthworms	3	0	19	0	42
Amphipoda	Sideswimmers	0	1	6	<1	0
Decapoda	Crayfish	0	0	1	0	0
Hydracarina	Watermites	0	0	1	<1	0
Plecoptera	Stoneflies	0	0	0	0	0
Ephemeoptera	Mayflies	33	12	33	38	0
Odonata	Dragonflies	<1	2	6	2	0
Trichoptera	Caddisflies	1	9	2	14	0
Coleoptera	Beetles	2	0	0	<1	0
Diptera	True Flies	106	103	16	82	25
Gastropoda	Snails	<1	4	2	4	0
Pelecypoda	Mussels	0	0	3	0	0

[a]Number per sample (0.1 m^2)
[b]Stream sites are listed in order of occurrence in the watershed, upstream to downstream locations (see Figure E7-5).

Table E2-5
(Continued)

Mean Benthic Macroinvertebrate Densities, OU1 Surface Water Sites, Woman Creek Drainage, Fall 1991[a]

		Stream Sites[b]				Pond Site
Taxon	**Common Name**	**SW039**	**SW033**	**WORI3**	**WORI1**	**SWC01**
Oligochaeta	Earthworms	3	6	19	0	316
Amphipoda	Sideswimmers	<1	3	4	19	0
Decapoda	Crayfish	0	0	0	0	0
Hydracarina	Watermites	0	0	0	1	0
Plecoptera	Stoneflies	0	2	0	0	0
Ephemeoptera	Mayflies	56	257	16	61	<1
Odonata	Dragonflies	4	24	4	13	0
Trichoptera	Caddisflies	8	51	1	7	0
Coleoptera	Beetles	0	5	1	3	0
Diptera	True Flies	34	76	8	107	193
Gastropoda	Snails	<1	25	1	14	0
Pelecypoda	Mussels	0	2	1	<1	0

[a]Number per sample (0.1 m^2)
[b]Same as Table E2-7

Table E2-6

Fish Species and Relative Abundance at OU1 Aquatic Sampling Stations[a,b]

	Woman Creek				South Interceptor Ditch (SID)			
	Stream Sites			Pond	Channel Sites			Pond
Species	**SW033**	**WORI3**	**WORI1**	**SW0C1**	**WOSP1**	**SW070**	**SW063**	**SW0C2**
Minnow Family								
Stoneroller	M		L	L				
Carp								
Gold Fish								
Fathead Minnow			L	L				H
Golden Shiner				H				
Creek Chub	M	L	L	L				
Sucker Family								
White Sucker				M				
Sunfish Family								
Green Sunfish				M				
Largemouth Bass			L	L				
No. Species Present	2	1	4	7	0	0	0	1

[a]Relative abundances determined using minnow traps, gill nets, and qualitative observations (H = high numbers; M = medium numbers; L = low numbers).
[b]Stream and channel sites listed in order of occurrence, from upstream to downstream locations (see Figure E7-5).

SECTION E3

CONTAMINANT SOURCES AND RELEASES

E3.1 SOURCES OF CONTAMINATION AT OU1

OU1 is composed of 11 IHSSs that were selected as high-priority sites because of the elevated concentration of volatile organic compounds (VOCs) detected in the groundwater, the relatively permeable soils, and the proximity of the area to a surface water drainage (Figure E1-1). The 11 IHSSs within OU1 include:

- Oil Sludge Pit Site (IHSS 102)
- Chemical Burial Site (IHSS 103)
- Liquid Dumping Site (IHSS 104)
- Out-of-Service Fuel Tank Sites (IHSSs 105.1 and 105.2)
- Outfall Site (IHSS 106)
- Hillside Oil Leak Site (IHSS 107)
- Multiple Solvent Spill Sites (IHSSs 119.1 and 119.2)
- Radioactive Site (IHSS 130)
- Sanitary Waste Line Leak (IHSS 145)

This section describes the initial indication of contaminant distribution and the motivation for investigation at these sites. Potential sources of contamination and releases at each IHSS are described in the following site-specific descriptions. Use of data from the Phase I, II, and III RFI/RIs in identifying COCs is described in Section E4.

E3.1.1 Oil Sludge Pit Site (IHSS 102)

In the late 1950s, 30 to 50 drums of nonradioactive oil sludge were disposed in a 25- by 80-foot pit, designated as IHSS 102. The pit subsequently was backfilled, and IHSS 102 was moved to its present location (Rockwell, 1988). Tetrachloroethene and common laboratory contaminants (methylene chloride, acetone, and bis(2-ethylhexyl)phthalate) were detected in soil samples at IHSS 102. Five VOCs were detected in subsurface soil samples related to IHSS 102, including trichloroethene and common laboratory contaminants (toluene, 2-butanone, acetone, and methylene chloride). Of the semivolatile organic compounds (SVOCs) detected in subsurface soil, five were polynuclear aromatic hydrocarbons (PAHs) (benzo(a)pyrene, chrysene, naphthalene, phenanthrene, and pyrene), four were substituted aromatics (1,3-dichlorobenzene, 4-nitrophenol, benzoic acid, and pentachlorophenol), and two were phthalates (bis(2-ethylhexyl)phthalate and di-n-butylphthalate). Americium-241, plutonium-239/240, radium-228, and tritium were the radionuclides detected, and antimony was the only metal above background levels in subsurface soil.

E3.1.2 Chemical Burial Site (IHSS 103)

IHSS 103, a circular pit 150 feet in diameter, reportedly was used to bury unknown chemicals. Analytes detected in soil samples include VOCs (methylene chloride, trichloroethene, and 4-methyl-2-pentanone) and SVOCs (fluorene, phenanthrene, and pyrene). The common laboratory contaminants acetone, 2-butanone, and bis(2-ethylhexyl)phthalate also were detected in the soil samples. VOCs detected in subsurface soil samples include chlorinated solvents (trichloroethene and tetrachloroethene) and common laboratory contaminants (toluene, 2-butanone, acetone, and methylene chloride). SVOCs detected in subsurface soil include di-n-butylphthalate (a common laboratory contaminant), Aroclor 1254 (a polychlorinated biphenyl (PCB)), and PAHs (benzo(a)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene). Radionuclides detected in subsurface soils at IHSS 103 include americium-241, cesium-137, plutonium-239/240, and radium-228. Three metals were detected above background in IHSS 103 subsurface soils, including barium, copper, and strontium.

E3.1.3 Liquid Dumping Site (IHSS 104)

Prior to 1969, IHSS 104 was reportedly used for disposal of unknown liquids, possibly including nickel carbonyl and iron carbonyl drums. Toluene and methylene chloride were the only VOCs detected in subsurface soil samples. Twenty-one SVOCs were detected including 3 substituted aromatics (benzoic acid, 2,4-dimethylphenol, and 4-methylphenol), di-n-butylphthalate, and 17 PAHs. Only three PAHs exceeded the contract reporting limit, including fluoranthene, phenanthrene, and pyrene. Cesium-137 and plutonium-239/240 were the only radionuclides exceeding background levels in IHSS 104, and strontium was the only metal exceeding background levels.

E3.1.4 Multiple Solvent Spill Site (IHSS 119.1)

IHSS 119.1 was used for scrap metal storage and as a drum storage area. Drums contained unknown quantities and types of solvents and wastes (Rockwell, 1988a). Tetrachloroethene, trichloroethene, and trichloroethane were detected in soil gas samples and surficial materials. Acetone, 2-butanone, 1,1,2-trichloroethane, and bis(2-ethylhexyl)phthalate were detected in bedrock and claystone. VOCs detected in surface soil include common laboratory contaminants (toluene, 2-butanone, acetone, and methylene chloride), chlorinated solvents (1,1,1-trichloroethane, 1,1-dichloroethene, carbon tetrachloride, tetrachloroethene, and trichloroethene), and bromomethane. SVOCs detected include PAHs (anthracene, fluoranthene, phenanthrene, and pyrene) and bis(2-ethylhexyl)phthalate. Radionuclides detected include americium-241, plutonium-239/240, radium-228, cesium-137, uranium-238, and uranium-233,-234. Metals detected above background were not sampled below 12 feet and may reflect a bias in the sample set.

E3.1.5 Multiple Solvent Spill Site - East (IHSS 119.2)

IHSS 119.2 is east of IHSS 119.1 and was used for storing scrap metal and drums with unknown quantities and types of solvents, as well as empty drums. Tetrachloroethane, methylene chloride, 2-butanone, and bis(2-ethylhexyl)phthalate were detected in samples taken from boreholes west of IHSS 119.2, and 1,1,1-trichloroethane, bis(2-ethylhexyl)phthalate, and di-n-butylphthalate were detected in samples taken within the IHSS. Toluene, acetone, and methylene chloride were the only VOCs detected in subsurface soil samples. Thirteen SVOCs were detected in subsurface soil samples, including PAHs (acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene), polychlorinated biphenyls (PCBs) (Aroclor 1248, and Aroclor 1254), and phthalates (bis(2-ethylhexyl)phthalate and di-n-butylphthalate). Americium-241 and plutonium-239/240 were the only radionuclides detected above background. Six metals were detected in subsurface soils: barium, cobalt, copper, lead, zinc, and cadmium.

E3.1.6 Radioactive Site - 800 Area Site #1 (IHSS 130)

Between 1969 and 1972, 400 tons of soil and asphalt contaminated with low levels of plutonium were disposed in the IHSS 130 area. Bis(2-ethylhexyl)phthalate, toluene, acetone, and methylene chloride were the only VOCs detected in subsurface soil samples. SVOCs were detected in subsurface soil samples, including PAHs (naphthalene, fluoranthene, and pyrene), two substituted aromatics (benzoic acid and pentachlorophenol), and di-n-butylphthalate. Americium-241, cesium-137, plutonium-239/240, and radium-228 were the only radionuclides detected above background. Three metals were detected above background in IHSS 130 subsurface soil samples, including barium, strontium, and cobalt.

E3.1.7 Vicinity of Building 881 (IHSSs 105.1, 105.2, 106, 107, and 145)

IHSSs 105.1, 105.2, 106, 107, and 145 are located in the vicinity of Building 881. IHSSs 105.1 and 105.2 are out-of-service fuel tanks that were used to store diesel fuel from 1958 to 1976. The tanks were later filled with asbestos-containing material and subsequently with concrete (Rockwell, 1988). Acetone and methylene chloride were detected southwest of the tanks.

IHSS 106 is a 6-inch-diameter vitrified clay pipe outfall that is an overflow line from a sanitary sewer sump first used for discharge of untreated sanitary wastes and later used for discharge of cooling tower blowdown. Tetrachloroethene was detected in soil gas and methylene chloride, acetone, 2-butanone, di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected in soil samples.

IHSS 107 is an area where oil was discovered flowing down the hillside south of Building 881. Tetrachloroethene, trichloroethane, trichloroethene, and dichloroethene were detected in soil gas and acetone, 2-butanone, trans-1,2-dichloroethane, trichloroethene, tetrachloroethene, and bis(2-ethylhexyl)phthalate were detected in soils and groundwater near IHSS 107.

IHSS 145 is an area where a 6-inch, cast-iron sanitary sewer line leaked on the hillside south of Building 881. The line had been used to convey sanitary wastes and low-level radioactive laundry effluent to the sanitary waste treatment plant. Five VOCs were detected in subsurface soil samples, including toluene, 2-butanone, acetone, methylene chloride, and tetrachloroethene. Eight SVOCs were detected in subsurface soil samples, including substituted aromatics (1,4-dichlorobenzene, 2,4-dinitrotoluene, 4-chloro-3-methylphenol, and 4-nitrophenol), phthalates (bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and diethylphthalate), and a PAH (pyrene). Three radionuclides, americium-241, plutonium-239/240, and uranium-233,-234, exceeded background levels in subsurface soil samples, as did five metals, including arsenic, barium, copper, cadmium, and selenium.

E3.1.8 Former Retention Pond

Although the former retention pond is not an IHSS at OU1, it is considered a potential source of contamination. The disposal history is unknown except that oil was observed leaking toward it from IHSS 102. Toluene and methylene chloride were the only VOCs detected in subsurface soil samples associated with the former retention pond. SVOCs detected in subsurface soil samples include PAHs (fluoranthene, phenanthrene, and pyrene) and phthalates (bis(2-ethylhexyl)phthalate and di-n-butylphthalate). Plutonium-239/240 was the only radionuclide and antimony was the only metal exceeding background levels in subsurface soil samples associated with the former retention pond.

E3.2 TYPES OF CONTAMINANTS EXPECTED

Based on information collected at each of the 11 IHSSs, the types of contaminants expected from OU1 surface soils include SVOCs and radionuclides. SVOCs occur in 24 of 28 sample locations at OU1, with total concentrations ranging from approximately 600 micrograms per kilogram (μg/kg) to more than 10,000 μg/kg. Radionuclides exceed background in soils locally to depths greater than 18 feet across OU1.

SECTION E4
CONTAMINANTS OF CONCERN

COCs are chemicals that are suspected to occur in environmental media as a result of activities at a OU1, and have the potential to damage natural populations or ecosystems. The OU1 EE focused on the toxicological effects, or potential effects, of the chemicals identified as COCs. This section describes the process by which COCs were identified, and provides rationale for the selection of each.

E4.1 SELECTION OF COCs

COCs for the OU1 EE were identified in two stages. First, preliminary list of contaminants was developed prior to field activities in 1991 and used to identify target analytes for tissue analysis. The preliminary list was developed from data collected during the Phase I and Phase II RFI/RIs. Although the data on which it was based were preliminary, the initial selection step was necessary to identify analytes for tissue analysis during Phase III field operations. This list included potentially toxic heavy metals and radionuclides detected at concentrations in OU1 soils and/or surface water that exceeded RFP background concentrations as presented in the Background Geochemical Characterization Report (DOE, 1990) (Table E4-1). Identification was based on concentrations of chemicals in soils within OU1 IHSSs and surface water and sediments of the SID and Woman Creek. Only chemicals known to bioaccumulate in terrestrial or aquatic organisms were selected for tissue analysis.

The second stage involved selection of the final COCs based on criteria that were developed in conjunction with EPA: (1) documentation of occurrence of the chemical in environmental media, (2) the extent of contamination at RFP, and (3) ecotoxicity of the chemical. The first two criteria, occurrence and extent of contamination, were addressed as a result of the analysis conducted for the "nature and extent" portion of the OU1 Phase III RFI/RI report. This analysis resulted in a list of metals, radionuclides, and organic chemicals characterized as potential contaminants at OU1 (Table E4-2). The approach for the analysis also was developed in conjunction with EPA and the Colorado Department of Health (CDH) and represents a consensus on the methods used. A detailed description of the analysis methods and results is contained in

Appendix D of the Phase III RFI/RI Report. Logic diagrams for identification of inorganic and organic contaminants are presented in Figures E4-1 and E4-2, respectively. Both contaminant screening methodologies specify examination of spatial/temporal concentration distributions and the potential for laboratory or field sampling artifact; however, screening of inorganic contaminants also involved statistical comparisons of site and background concentrations. The extent of contamination was further evaluated in the EE by assessing the frequency of detection within OU1 media (Table E4-3).

Chemicals identified as contaminants in Appendix D were evaluated for the third COC selection criterion, ecotoxicity. This process is equivalent to the "concentration-toxicity" screen of the human health risk assessment (EPA, 1989c). The contaminants were "screened" for potential ecotoxicity by comparing the maximum concentration detected for a given medium to toxicity reference values (TRVs) derived from scientific literature (Table E4-4). TRVs are benchmark concentrations above which adverse ecological effects may be expected. TRVs were determined for various receptors and exposure pathways according to the procedure described in Section E5. Derivation of TRVs included consideration of potential acute and chronic toxicity and emphasized sublethal effects to various receptor groups.

If the maximum concentration in a given medium exceeded the TRV, the chemical was included in the COCs. A chemical for which concentrations did not exceed the TRV would have been retained if it (1) occurred in several media or (2) was known to biomagnify, thus resulting in toxic exposure to upper-level consumers even at low ambient concentrations. Biomagnification was considered important only if bioconcentration factors greater than 100 were known for a particular contaminant (ASTM, 1985; Fordham and Reagan, 1991).

For purposes of the COC screen, concentrations of organic contaminants in vegetation were considered to be the same as those in soils. This is a conservative assumption because, in general, organic contaminants with octanol-water partition coefficients (K_{ow}) greater than approximately 2.5 do not tend to accumulate in plant tissues (Baes, 1984; Travis and Arms, 1988).

Neither Colorado state water quality standards nor EPA Ambient Water Quality Criteria (AWQC) had been developed for many of the organic contaminants because there were insufficient toxicological data for the agencies to do so. When insufficient data are available to establish AWQC, EPA often reports a lowest-effects concentration (LEC). TRVs for organic compounds were calculated from the acute LEC by dividing by 8.7, a conservative estimate for the acute to chronic ratio for chlorinated aliphatics (EPA, 1980), and by 3.5, the factor required when estimating a no-observed-effects level (NOEL) from an LEC (see Section E5). If a chronic LEC was available, only the latter conversion was made.

COCs were identified for soil (surface and subsurface combined), surface water, and sediment. Chemicals identified as COCs for the OU1 EE are presented in Table E4-5. The rationale on which chemicals were included or excluded is presented below. Further information on the potential ecotoxicity of COCs is presented in Section E5.

E4.2 IDENTIFICATION OF OU1 COCs

E4.2.1 Selenium

Selenium was detected at elevated concentrations in groundwater beneath OU1 but did not exceed Rocky Flats background concentrations at surface water sampling sites or in surface or subsurface soil. Thus, it was identified as a contaminant in groundwater but not in other media. Selenium is a metalloid that exists in several forms. Elemental selenium and inorganic selenide have limited bioavailability to animals and therefore limited toxicity (Maier *et al.*, 1993). However, selenium is taken up by some plant species, especially legumes, and could accumulate to levels considered potentially toxic to animals (5 to 15 parts per million [ppm])(Eisler, 1985; Mayland *et al.*, 1989; Arthur *et al.*, 1993). Selenium was included as a COC for this reason.

E4.2.2 Vanadium

Vanadium was identified as a contaminant only in groundwater at OU1. The maximum concentration in unfiltered samples was 403 micrograms per liter (μg/L) while the maximum dissolved concentration was 44 μg/L. Vanadium concentrations exceeded background in 11 percent of filtered samples from OU1. The primary exposure pathway for vanadium is direct contact with plant roots. There was no data available on toxicity of vanadium to plants. Maximum groundwater concentrations were three orders of magnitude below threshold effects on growth of chickens, 20 milligrams per kilogram (mg/kg)(Berg *et al.*, 1963). The mean concentration in alluvial at OU1, 9.5 μg/L, was only slightly greater than background. Vanadium was not included in the COCs because of limited exposure and relatively low environmental concentrations.

E4.2.3 Plutonium-239,-240

Plutonium was commonly used in manufacturing processes at Rocky Flats. Documented releases have occurred including those resulting in plutonium deposition at IHSSs 119.1 and 119.2. Plutonium was elevated in greater than 5 percent of surface and subsurface soil samples. It was not elevated in surface water or sediment but was included as a possible contaminant in these media because of the potential for widespread contamination at RFP. Plutonium was included in the COCs because it is one of the primary contaminants at RFP and characterization of ecological risk is important to the overall assessment of contamination.

E4.2.4 Americium-241

Americium is a decay product of plutonium and therefore often occurs with plutonium in the environment. Like plutonium, americium was elevated in surface and subsurface soils at OU1 and was presumed to be widely distributed on the site. Americium was included in the OU1 COCs.

E4.2.5 Uranium-233,-234

Uranium was elevated in surface and subsurface soils. Uranium isotope ratios in OU1 samples indicate that much of the uranium at OU1 is of natural origin. However, uranium was used in certain processes in Building 881, and the elevated content in environmental media could be a result of accidental releases. Uranium was included in the COCs.

E4.2.6 Dichloroethanes

Concentrations of the isomers 1,1-dichloroethane and 1,2-dichloroethane exceeded detection limits in groundwater, surface water, and soil samples at OU1 (Table E4-3). No data were available on noncarcinogenic toxicity of dichloroethane (DCA). The lowest dose associated with carcinogenesis in mice was 47 milligrams per kilogram body weight per day (mg/kg bw-day). The deer mouse consumes approximately 3.2 grams (g) of food per day (see Attachment E-1 for details of life history information for selected receptors). If the concentration of DCA in vegetation in OU1 was equal to the maximum concentration in soils, the deer mouse would ingest 2×10^{-3} mg DCA/kg bw-day. A similar estimate for mule deer is 2.6×10^{-4} mg/kg bw-day. Both of these values are greater than 1,000 times less than the lowest carcinogenic dose reported by EPA (1993). EPA reports a chronic LEC of 2×10^{4} μg/L, which corresponds to a TRV of 5,714 μg/L. The maximum DCA concentration detected in surface water at OU1 was 14 μg/L. The maximum concentration detected in groundwater, 35 μg/L, is not likely to be vegetation roots contacting contaminated groundwater (Table E4-4). DCAs were not included in the COCs because the low detection frequency and maximum site concentrations were well below the threshold levels required for toxic effects.

E4.2.7 Dichloroethenes

Isomers of dichloroethene were detected in groundwater, surface water, and subsurface soils at OU1 (Table E4-3). Quast *et al.* (1983) estimated a lowest-observed-effects level (LOEL) for laboratory rats of 9 mg/kg bw-day. No mortality or clinical effects occurred at this concentration, but some hepatocellular swelling was indicated in female rats. Similar effects in male rats were not significant at concentrations less than 200 mg/kg. The maximum DCE concentration in soils at OU1 was 12 μg/kg of soil. Deer mice consuming vegetation containing this concentration of DCE would ingest approximately 2×10^{-3} mg/kg bw-day. The EPA reports an LEC (acute) of 11,600 μg/L for protection of aquatic life (EPA, 1980). This LEC corresponds to a TRV of 368 μg/L. The maximum surface water concentration detected at OU1, 5 μg/L, was three orders of magnitude under the acute LEC and 122 times less than the TRV. DCE do not tend to bioaccumulate because they are metabolized rapidly and have a low octanol/water partition coefficient (log K_{ow}=1.48). Using the K_{ow}, the predicted bioconcentration factor (BCF) for 1,1-dichloroethene is approximately 2.0. Although no data were available for DCE, a related compound, tetrachloroethene (PCE), added to nutrient solution affected growth of *Lactuca sativa* with an EC_{50} of 12,000 μg/L (Hulzebos *et al.*, 1993). The highest concentration of DCE in groundwater was 18,000 μg/L. Therefore, DCE was included in the COCs and will be assessed for exposure to vegetation. In addition, the potential for DCE to volatilize into air within animal burrows from soil gas will be analyzed.

E4.2.8 Carbon Tetrachloride

Carbon tetrachloride was detected in groundwater and subsurface soils (Table E4-3). No carbon tetrachloride was detected in surface waters or sediments. The maximum carbon tetrachloride concentration in soils at OU1 was 18 μg/kg (Table E4-4). Bruckner *et al.* (1986) report a NOEL for ingestion by rats of 0.71 mg/kg bw-day. Deer mice consuming vegetation containing carbon tetrachloride at maximum soil concentration would ingest 3 x 10^{-3} mg/kg bw-day. Mule deer would consume 4 x 10^{-4} mg/kg bw-day. Carbon tetrachloride apparently does not bioconcentrate readily (Pearson and McConnel, 1975). Carbon tetrachloride will be assessed for effects on vegetation exposed to groundwater because the maximum concentration exceeded TRVs for exposure of vegetation to other chlorinated hydrocarbons. Additionally, carbon tetrachloride will be assessed for potential volatilization into air within animal burrows.

E4.2.9 Chloroform

Chloroform was detected groundwater and subsurface soils, but was not detected in surface water or sediments (Table E4-3). The maximum concentrations in groundwater and soils were 170 μg/L and 5 μg/kg, respectively (Table E4-4). EPA (1993) reports a lowest-observed-adverse-effects level (LOAEL) of 12.9 mg/kg-day for sublethal effects in dogs (see also Heywood *et al.*, 1979). This corresponds to a TRV of 2 mg/kg bw-day. Deer mice and mule deer consuming vegetation at the maximum soil concentration would ingest 8.5 x 10^{-4} and 1.1 x 10^{-4} mg/kg bw-day, respectively. These values are several orders of magnitude below the threshold effects in dogs. Chloroform was not included in the COCs because of low detection frequency in soils and low environmental concentrations relative to toxic thresholds.

E4.2.10 Trichloroethanes

Trichloroethanes (TCAs) were detected in groundwater, subsurface soil, surface water, and sediments at OU1 (Table E4-3). The maximum soil concentration at OU1 was 5 μg/kg (Table E4-4). EPA (1993) reports a NOEL of 90 mg/kg bw-day for ingestion of TCA by guinea pigs. This corresponds to a TRV of 45 mg/kg bw-day. Deer mice and mule deer consuming vegetation containing maximum soil concentrations would ingest 8.5×10^{-4} and 1.1×10^{-4} mg/kg bw-day, respectively, several orders of magnitude below toxicity thresholds. The TRV for exposure of vegetation to TCA in soil is 166 mg/kg and is derived from a median effective concentration (EC_{50}) of >1,000 mg/kg (Hulzebos *et al.*, 1993). The maximum groundwater concentration at OU1 of 19,000 μg/L is above the toxic levels for exposure of vegetation to TCA in nutrient solutions. EPA reports an acute LEC of 18 mg/L for exposure of aquatic life (EPA 1993). This value corresponds to a TRV of 600 μg/L. The maximum concentration of TCA in surface water at OU1 was far below these levels at 4 μg/L. TCA was included in the COCs for evaluation of exposure of vegetation to localized contaminated groundwater (hot spots), potential exposure of burrowing mammals to TCA in air, and exposure of aquatic organisms to sediments.

E4.2.11 Trichloroethene

Trichloroethene (TCE) was detected in groundwater, subsurface soils, and surface water (Table E4-3). The maximum soil concentration was 140 μg/kg (Table E4-4). EPA (1993) reports an acute LD_{50} of 2,402 mg/kg bw-day for ingestion of TCE by mice. This value corresponds to a TRV of 200 mg/kg bw-day. Deer mice consuming vegetation containing 140 μg/kg TCE would ingest 0.02 mg/kg-day of the contaminant, far below the toxic threshold. No data were available for exposure of vegetation to TCE in soils or groundwater. However, the maximum groundwater concentration of 14 mg/L exceeds the TRVs for exposure to PCE and TCA. Therefore, TCE was included in the COCs for exposure of vegetation to contaminated groundwater and exposure of burrowing mammals to air in burrows.

E4.2.12 Tetrachloroethene

PCE was detected in groundwater, soil, and surface water samples (Table E4-3). EPA (1993) reports a NOEL of 14 mg/kg-day for ingestion of PCE by mice (see also Buben *et al.*, 1985). Deer mice and mule deer consuming vegetation at the maximum soil concentration, 170 μg/kg, would ingest 2.9 x 10^{-2} and 3.7 x 10^{-3} mg/kg bw-day, respectively. These values are several orders of magnitude below toxicity thresholds for mammals. The chronic LEC for exposure to aquatic life is 840 μg/L corresponding to a TRV of 240 μg/L (EPA, 1993). The maximum surface water concentration at OU1, 2 μg/L, was well below these levels. The maximum soil concentration was well below the TRV of 166 mg/kg for exposure of vegetation to contaminated soil (Table E4-4). However, groundwater concentrations exceeded levels toxic to vegetation (2,000 μg/L)(Hulzebos *et al.*, 1993). Therefore, TCE was included in the COCs for analysis of exposure of vegetation to contaminated groundwater and exposure of burrowing mammals to burrow air.

E4.2.13 Toluene

Toluene was detected in groundwater, subsurface soils, surface water, and sediment at OU1 (Table E4-3). EPA reports a no-observed-adverse-effects level (NOAEL) of 223 mg/kg-day for ingestion of toluene by rats (EPA, 1993). This corresponds to a TRV of 111 mg/kg bw-day. Deer mice consuming vegetation at the maximum soil concentration, 2 mg/kg, would ingest 0.3 mg/kg bw-day, well under the toxic threshold. TRVs for exposure of vegetation to toluene in soils and groundwater are 166 mg/kg and 915 μg/L, respectively (Table E4-4). The maximum soil concentration, 2 mg/kg, and the maximum groundwater concentration, 270 μg/L, at OU1 were below these thresholds. The maximum surface water concentration was 5 μg/L, well under the chronic LEC of 1,750 (EPA, 1993) and the corresponding TRV of 500 μg/L (Table E4-4). Toluene was included in the COCs for assessment of exposure of aquatic life to contaminated sediments.

E4.2.14 Total Xylenes

Xylenes were detected in groundwater, soils, and surface water (Table E4-3). The maximum concentration detected in soils was 3 μg/kg (Table E4-4). Deer mice consuming vegetation at this concentration would ingest 5 x 10^{-4} mg/kg bw-day, well under the NOAEL of 179 mg/kg bw-day reported by EPA (EPA, 1993). Vegetation exposed to xylenes in soils or groundwater are also not likely to be affected. The TRVs for exposure of vegetation to xylene in soils and groundwater are 166 mg/kg and 350 μg/L, respectively. Xylenes were not included in the COCs because of low frequency of detection and low environmental concentrations.

E4.2.15 Polynuclear Aromatic Hydrocarbons

Various PAHs were detected in soils and sediments at OU1 (Table E4-3 and E4-4). Benzo(a)pyrene (BaP) is one of the more toxic PAHs; therefore, data for this chemical were evaluated during the COC selection process. The maximum soil concentration of BaP in these media was 750 μg/kg. Dermal exposure to a concentration of 300 μg/kg has been shown to cause skin cancer in mice and therefore may affect populations of mice or other mammals that spend the early part of their lives in burrows (Kappleman, 1993). An ingested dose of 10 mg/kg bw-day of BaP induced fetal mortality in mice. Deer mice at OU1 consuming vegetation containing the maximum soil concentration, 3,335 μg/kg, would ingest 0.56 mg BaP/kg bw-day. Maximum BaP concentrations at OU1 could represent a hazard to terrestrial and aquatic wildlife at OU1. Most vegetation species can metabolize PAHs and generally accumulate them in internal tissues. Thus, PAHs were included in the COCs and will be analyzed for exposure of animals to contaminated soil through dermal contact and ingestion of contaminated food items. Exposure of aquatic organisms to contamination in sediments will also be assessed.

E4.2.16 Polychlorinated Biphenyls

PCBs have caused lethal and sublethal effects including reproductive impairment in several species including mammals, birds, and fish (Eisler, 1987). PCBs readily bioconcentrate in aquatic systems and can biomagnify in both terrestrial and aquatic systems. Boucher (1993) estimated an effects criterion of 25 mg PCB/kg soil to protect mink, an extremely sensitive species and a top predator. The effects criterion is based on PCB toxicity to mink and empirically determined BCF (0.09) for transfer of PCBs from soils to deer mice. Aroclor 1254 was detected in surface soils and sediments, while Aroclor 1248 was detected only in surface soils (Table E4-3). The maximum Aroclor 1254 in soils at OU1, 1.2 mg/kg, was about 20 times lower than the above effects criterion. However, PCBs were included in the COCs because of their capacity to bioaccumulate. PCBs will be assessed for exposure of terrestrial wildlife through ingestion pathways and for aquatic wildlife through ingestion and contact with contaminated sediments.

Table E4-1

Preliminary Contaminants of Concern for the OU1 Environmental Evaluation

Metals	Radionuclides	Inorganics
aluminum (Al)	americium-241 (Am)[a]	cyanide (Cn)
arsenic (As)	plutonium-239,-240 (Pu)[a]	
beryllium (Be)	radium-226 (Ra)	
cadmium (Cd)	strontium-90 (Sr)[a]	
chromium (Cr)	uranium (total) (U)	
copper (Cu)	gross alpha	
iron (Fe)	gross beta	
lead (Pb)		
manganese (Mn)		
mercury (Hg)		
nickel (Ni)		
silicon (Si)		
silver (Ag)		
zinc (Zn)		

[a]Not identified as a COC in OU1 Field Sampling Plan

Table E4-2

Contaminants at OU1

Analyte	Medium				
	Surface Soils	Subsurface Soils	Ground-water	Surface Water/ Seeps	Sediments
Metals					
Selenium			X		
Vanadium			X		
Radionuclides					
Plutonium	X[a]	X[a]		X[b]	X[b]
Americium	X	X[a]		X[b]	X[b]
Uranium	X[a]	X[a]			
Volatile Organic Compounds					
1,1-Dichloroethane			X	X	
1,2-Dichloroethane		X	X	X	
1,1-Dichloroethene		X	X	X	
1,2-Dichloroethene			X	X	
cis 1,2-Dichloroethene			X		
Carbon Tetrachloride		X	X		
Chloroform		X	X		
1,1,1-Trichloroethane		X	X	X	X
1,1,2-Trichloroethane			X		
Trichloroethene		X	X	X	
Tetrachloroethene		X	X	X	
Toluene		X	X	X	X
Total Xylenes		X	X	X	
Semivolatile Organics					
PAHs	X	X			X
Aroclor-1254	X				X
Aroclor-1248	X				

[a]Based on 1992-93 "hot spot" data

[b]Presumed to be present as a contaminant because of the widespread nature of the contamination originating from an offsite source

Table E4-3

Occurrence of Contaminants at OU1

Analyte	Medium				
	Surface Soils	Subsurface Soils	Ground-water	Surface Water [a]	Sediments
Metals [a]					
Selenium			36		
Vanadium			44		
Radionuclides [b]					
Plutonium-239,240	88	50		6	6
Americium-241	82	50		11	0[e]
Uranium-233,234	3	3			
Volatile Organic Compounds [c]					
1,1-Dichloroethane			5	1	
1,2-Dichloroethane		<1	2	2	
1,1-Dichloroethene		<1	13	1	
1,2-Dichloroethene			4	<1	
cis 1,2-Dichloroethene			5		
Carbon Tetrachloride		<1	16		
Chloroform		<1	19		
1,1,1-Trichloroethane		<1	14	1	9
1,1,2-Trichloroethane			3		
Trichloroethene		2	34	3	
Tetrachloroethene		2	28	2	
Toluene		97	10	3	15
Total Xylenes		<1	3	<1	
Semivolatile Organics [c]					
PAHs[d]	50	2			8
Aroclor-1254	8				20
Aroclor-1248	4				

[a]Total concentrations (not filtered)

[b]Values are the percent of total samples exceeding Rocky Flats background

[c]Values are the percent of total samples in which chemical was detected

[d]Value for benzo(a)pyrene

[e]Presumed to be present because of widespread nature of contamination from offsite source

Table E4-4

Maximum Concentrations, Toxicity Reference Values (TRVs), and Bioconcentration Factors (BCFs) for Use in Selection of OU1 Contaminants of Concern[a]

Contaminant	Max. Surface Water Conc. (μg/L)	Max. Sediment Conc. (μg/kg)	Max. Groundwater Conc. (μg/L)	Max. Soil Conc. (μg/kg)	Aquatic TRV[b] water (μg/L)	Aquatic TRV[b] sediment (μg/kg)	TRV for Mammals and Birds[c]	TRV for Vegetation soil (μg/kg)	TRV for Vegetation water (μg/L)	BCF
Metals										
Selenium	--		28,200		17		5 mg/kg in diet			
Vanadium	--		44				3.3 mg/kg in diet			
Radionuclides										
Plutonium	0.092 pCi/L	--	--	11,100 pCi/kg			0.1 rad/day[d]	0.1 rad/day[d]		
Americium	0.94 pCi/L	--	--	2,650 pCi/kg			0.1 rad/day	0.1 rad/day		
Uranium	14 pCi/L	--	--	4.69 pCi/kg			0.1 rad/day	0.1 rad/day		
Volatile Organic Compounds										
1,1-Dichloroethane	3	--	35		5,714		47,000 μg/kg bw/day	>166,000	2,000	
1,2-Dichloroethane	14	--	29	5	5,714		47,000 μg/kg bw/day	>166,000	2,000	
1,1-Dichloroethene	5	--	18,000	12	368		2,600 μg/kg bw/day	>166,000	2,000	
cis 1,2-Dichloroethene	--	--	0.9	--	368		2,600 μg/kg bw/day	>166,000	2,000	
Carbon Tetrachloride	--	--	4,500	18	1,156		710 μg/kg bw/day	>166,000	2,000	
Chloroform	--	--	170	5	354		2,000 μg/kg bw/day	>166,000	2,000	21
1,1,1-Trichloroethane	4	7	19,000	6	600	1.60	45,000 μg/kg bw/day	>166,000	17,000	65
1,1,2-Trichloroethane	4	--	84	--	604		45,000 μg/kg bw/day	>166,000	17,000	
Trichloroethene	8	--	14,000	140	6,250		200,000 μg/kg bw/day	>166,000	2,000	52
Tetrachloroethene	2	--	6,000	170	240		14,000 μg/kg bw/day	>166,000	2,000	41
Toluene	5	8	270	2,000	500	2.80	111,000 μg/kg bw/day	>166,000	915	
Total Xylenes	1	--	120	3			179,000 μg/kg bw/day	>166,000	350	49
Semivolatile Organics										
PAHs[c]	--	380[e]	--	3,335		818[e]	10,000 μg/kg			
Aroclor-1254	--	86	--	1,200	0.014	0.019	690 μg/kg[f]			10^4 to 10^6
Aroclor-1248	--	--	--	670			690 μg/kg[f]			10^4 to10^6

[a]Units indicated in column heading unless otherwise noted

[b]Based on direct exposure in water

[c]Based on ingestion pathway

[d]Based on total body dose

[e]Value for fluoranthene

[f]Value based on soil concentration and accounts for bioaccumulation

-- not detected or not a contaminant for this medium

Table E4-5

Environmental Evaluation Contaminants of Concern

Analyte	Aquatic Species[a]	Terrestrial Vegetation[b]	Terrestrial Herbivores[c]	Terrestrial Carnivores[d]	Biomag-nification[e]
Selenium			X	X	X
Plutonium-239,240		X	X	X	
Amercium-241		X	X	X	
Uranium		X	X	X	
Carbon Tetrachloride		X			
1,1,1-Trichloroethane	X	X			
Trichloroethene		X			
Tetrachloroethene		X			
1,1-Dichloroethene		X			
Toluene	X				
PAHs	X		X	X	X
PCBs (Aroclor-1248 and -1254)	X		X	X	X

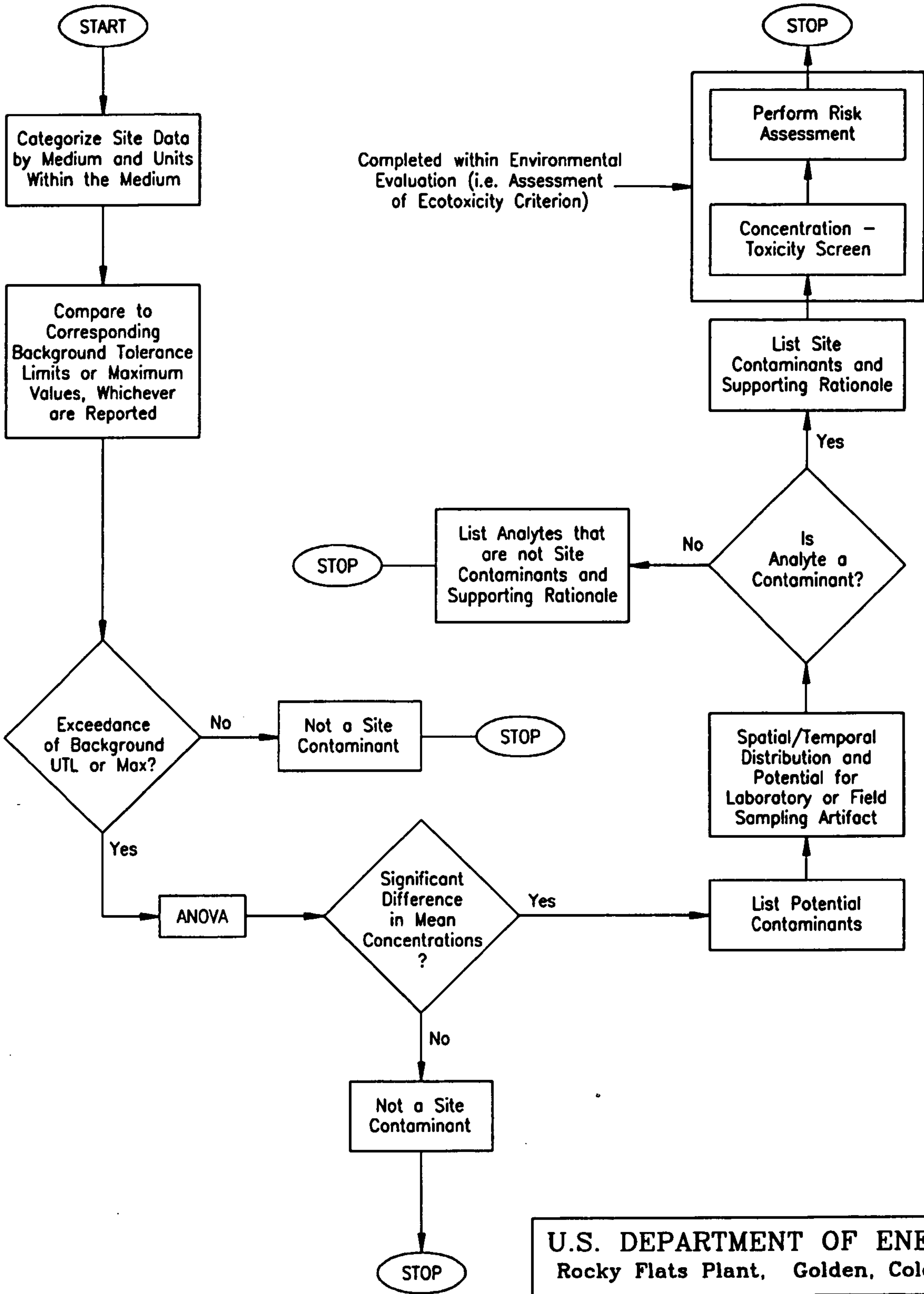
[a]Aquatic species were evaluated for direct exposure to contaminants in surface water and sediment

[b]Plants were evaluated for direct exposure to contaminants in soils and shallow groundwater

[c]Terrestrial herbivores were evaluated for ingestion of vegetation, surface water, and soil (where data are available to evaluate direct soil ingestion)

[d]Terrestrial carnivores were evaluated for ingestion of prey and surface water

[e]The potential for increased exposure via biomagnification were evaluated for selenium, PAHs, and PCBs



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Determination of Site Contaminants
Inorganic Analytes

Figure E4-1

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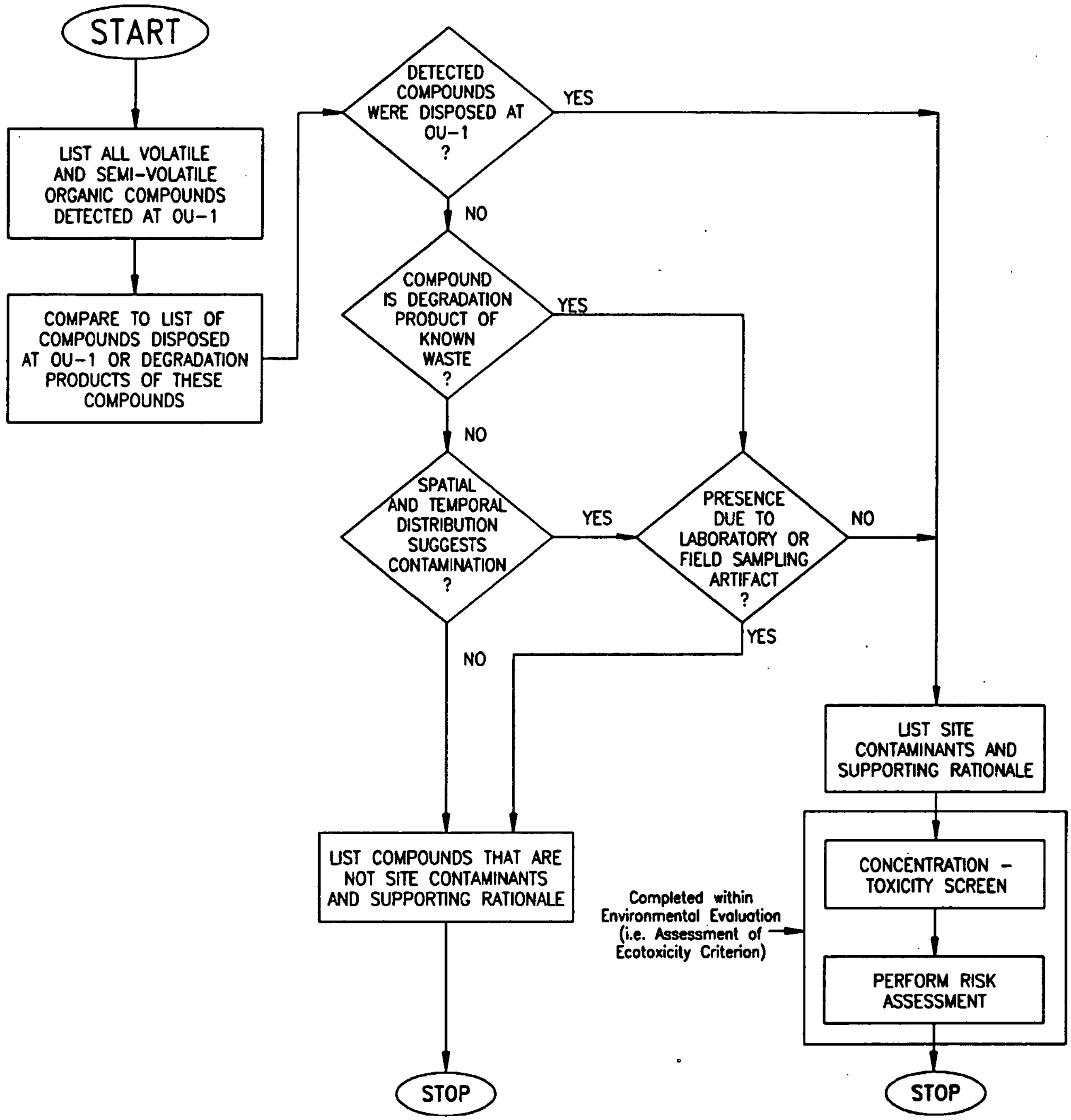

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Determination of Site Contaminants Volatile and Semi-Volatile Organic Analyte

Figure E4-2

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SECTION E4

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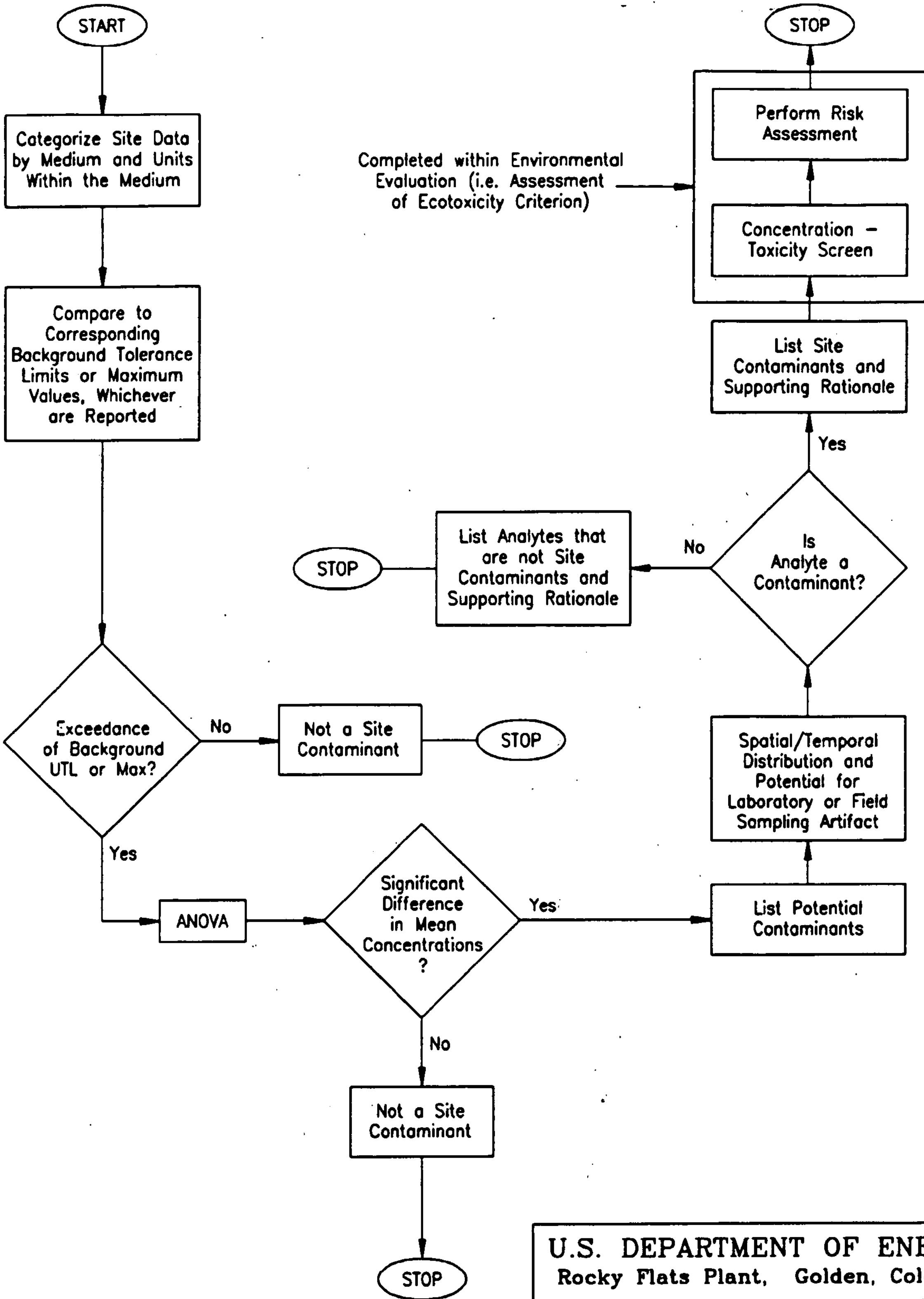

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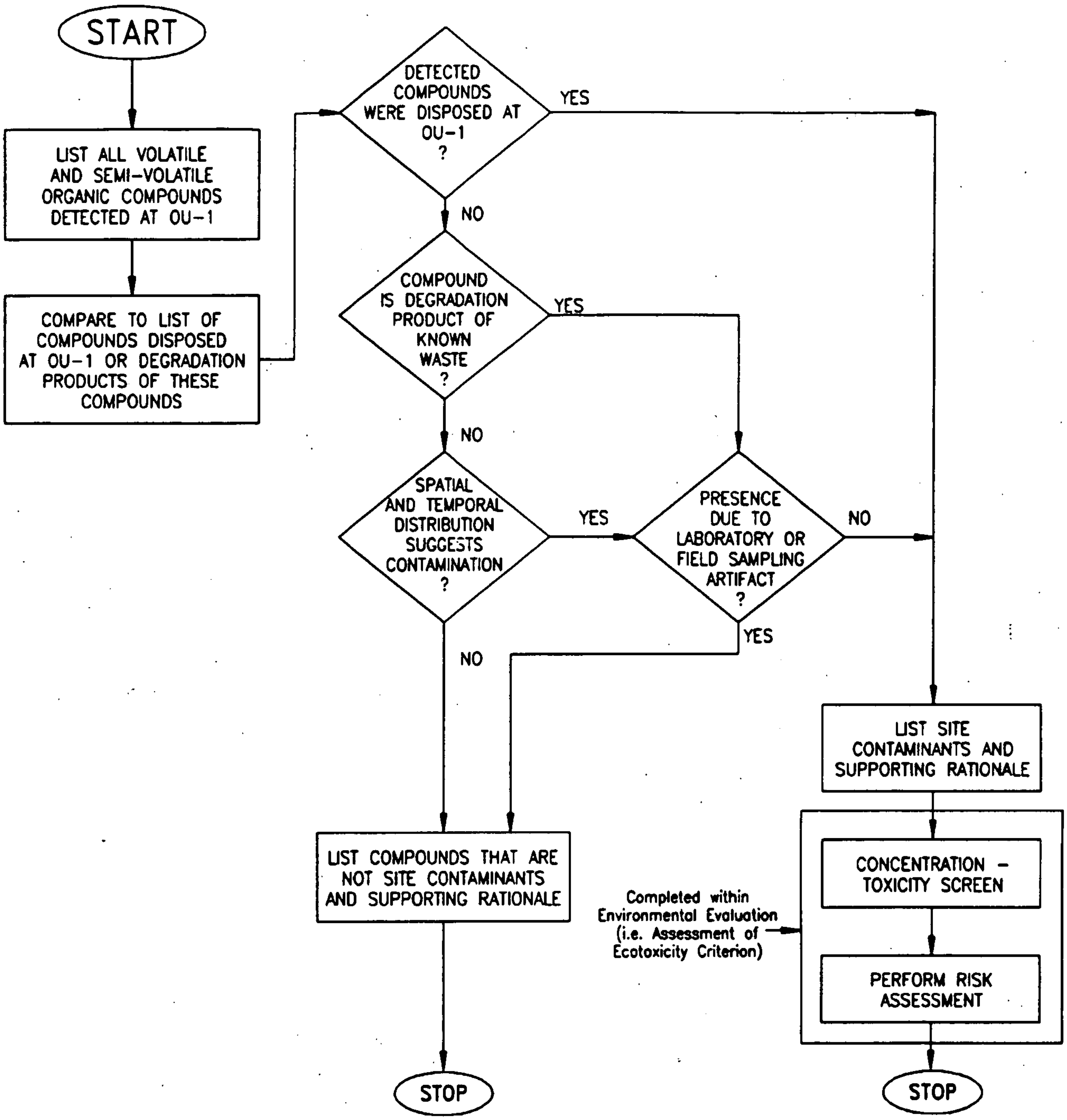

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Determination of Site Contaminants Volatile and Semi-Volatile Organic Analyte

Figure E4-2

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SECTION E5
TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to characterize the potential toxicity of the chemicals identified as COCs for the OU1 EE. This section summarizes potential toxicity and exposure pathways of COCs to ecological receptors. In addition, general toxicological information on each COC was used to develop toxicological reference values for comparison with actual and estimated exposures at OU1.

E5.1 METHODS

The evaluation of ecological risks associated with contamination at OU1 consisted in part of comparing the actual or estimated concentrations of COCs in environmental media to reference concentrations that might be expected to have an adverse impact (EPA, 1989a, b; Fordham and Reagan, 1991; DOE, 1991a;). The benchmark values for human health risk assessments, called reference doses (RfDs), are reviewed by EPA for use-based risk assessments involving human populations and are often available from EPA-sponsored databases and the available literature. This method or versions of it have also been applied in ecological risk assessments (EPA, 1989a, 1992a, 1992c; CDH, 1990). However, formal reference values are not readily available for most animal and plant species and must be derived from various sources. This section describes the process by which reference values were derived for use in this EE.

Toxicity reference values (TRVs) (CDH, 1990) were developed for exposure of major taxonomic groups to each COC. Data for TRV development were derived from regulatory standards and guidance and scientific literature in environmental toxicology. TRVs were developed for specific exposure routes (e.g., ingestion, dermal contact) and were based on the no-observed-effects level (NOEL) for exposure of sensitive species to a given toxin. The TRV was then used to estimate ecological effects criteria (EECs), or the chemical concentrations in abiotic or biotic media that are not likely to adversely affect the ecosystem (Fordham and Reagan, 1991; Maughan, 1993). The TRV and the effects criterion may be the same value where exposure occurs by direct contact with contaminated media such as groundwater, surface water, or soil. However, where ingestion or inhalation routes are involved, the criterion is calculated from the TRV to represent the concentration in abiotic media that results in acceptable exposure to the ecological receptor in question. The following sources of information were used to develop reference values:

- Colorado State Water Quality Standards
- EPA Ambient Water Quality Criteria (AWQC)
- EPA-sponsored on-line databases such as Integrated Risk Information System (IRIS) and Aquatic Information Retrieval (AQUIRE)
- Scientific or medical literature concerning toxicity and bioaccumulation of the chemicals in question

The methods for estimating reference values are presented in the following subsections. In some cases, description of reference values, methods refer to equations used in the Exposure Assessment (Section E6.)

E5.1.1 Development of Toxicity Reference Values

The first step in selection of TRVs was to gather information on the toxicity of each of the COCs to five major groups: vegetation, terrestrial invertebrates, small mammals, birds, and aquatic life.

The use of data to develop TRVs was prioritized as follows:

- Regulatory standard or AWQC (aquatic taxa only)
- Formally derived data relating to concentrations causing important sublethal effects such as the lowest-observed-adverse-effects concentration (LOAEC), no-observed-adverse-effects concentration (NOAEC), maximum allowable tissue concentration (MATC), and median effective concentration (EC_{50})
- Less well-defined values for concentrations causing sublethal effects were used
- Formally derived median lethal exposures such as the median lethal dose (LD_{50}), median lethal concentration (LC_{50}), etc.
- Less well-defined concentrations causing mortality

The procedure employed to select TRVs included steps intended to account for the possible uncertainty introduced by the use of different types and sources of data. Safety factors were applied to avoid possible underestimation of toxicity. The procedure is inherently conservative in that sublethal effects were used when available, and data were used for the most sensitive species noted in the literature. The method follows rationale presented by Lewis *et al.* (1990) and Fordham and Reagan (1991). Each source of uncertainty and the procedure for including estimates in the development of the TRV are summarized below. The overall process for identifying TRVs is depicted in Figure E5-1.

Uncertainty results when toxicity information is extrapolated from a specific study to general applicability. Several sources of uncertainty and various means of accounting for uncertainty in setting regulatory standards or estimating hazards have been suggested (Dourson and Stara, 1983; EPA, 1985, 1986, 1989a, 1989b; Lewis *et al.*, 1990). Major sources of uncertainty include intraspecific variation, interspecific variation, extrapolation from laboratory results to field data, and differences among field sites. In addition, the applicability of data extracted from the literature depends upon the type of result presented and the methods used to arrive at the results. The type of result reported may be a formally defined toxicological endpoint such as an LD_{50} or LOAEC or a less stringently defined measure of mortality or sublethal effect. Also considered is the probability that an effect was actually caused by the agent in question or can be ascribed to other causes (Lewis *et al.*, 1990).

The toxicity of many chemicals is known to depend on the conditions of exposure. For example, the toxicity of many metals to aquatic organisms is dependent upon the pH, hardness, and total organic carbon content of the water. Conditions under which the studies reviewed were conducted were highly variable, as were the toxic concentrations reported. Consequently, the application of results from a particular study to another site introduces some uncertainty into results and conclusions. To counter this uncertainty, the lowest toxic value encountered in the literature for the taxon was used to calculate the TRV.

Safety factors were applied to toxicity information derived from the literature to account for intraspecific variation in sensitivity to toxins. The safety factors described are based on empirical observations from many studies in which the actual relationships among statistically derived toxicity parameters were evaluated (Lewis *et al.*, 1990). This approach was used to estimate the NOEL when this parameter for exposure of a given species to a given chemical was not available. Available lowest-observed-effects level (LOELs) were reduced by a factor of 3.5, which was the average LOEL to NOEL ratio for 27 terrestrial species (Weil and McCollister, 1963). When concentrations causing an effect were defined as an EC_{50} or similar value, or when effective concentrations were not formally defined, the lowest concentration having an effect was divided by 5. Application of this factor to the EC_{50} approximated the NOEL in 96 percent of cases studied for laboratory mammals (Weil and McCollister, 1963). When median lethal exposures such as an LD_{50} or LC_{50} were used, the concentration was reduced by a factor of 6 (Weil, 1972; Lewis *et al.*, 1990). When lethal exposures were presented, but no formal toxicological endpoint was derived, the lowest concentration showing lethal levels was also reduced by a factor of 6. This procedure provides protection to the most sensitive organisms in the environment; therefore, impacts to populations, communities, or the ecosystem are unlikely at this reduced concentration.

Interspecific variation in sensitivity represents the most important source of error in environmental risk assessment but may also be the most difficult to determine. For example, for a group of 12 fish species, the MATC for cadmium exposure in ambient water differed by a factor of 6 between the most sensitive and most resistant species (Rand and Petrocelli, 1985).

Uncertainty due to interspecific variation was countered in two ways. For each taxon, the toxicity values for the most sensitive species encountered were used as the base value. For most taxonomic groups, this selection overestimated the sensitivity of the most resistant species by a factor of at least 5 and usually more than 10. Where possible, the toxicity values were chosen for species within the same genus or family as species found at RFP. In most cases, however, the literature was sparse and examples could be found only within the same class or order. When comparable toxicity values were available for fewer than five families, the toxicity value was reduced by a factor of 2, based on the assumption that the lowest toxic values found represent the sensitive end of the toxicity spectrum for a given taxon. If values were available for five or more families, the lowest value was used. Information on toxicity of COCs to aquatic invertebrates and fish was treated as recommended by EPA (EPA, 1985) and applied in the AWQC (EPA, 1992b).

For some organic compounds, few noncarcinogenic data were available. In these cases, the lowest concentration or dose eliciting a carcinogenic response was used without modification.

When available, Colorado Water Quality Standards and EPA AWQC were used without modification in development of surface water TRVs. State standards specifically for protection of aquatic life have been promulgated for some metals and water quality parameters, but not for organic compounds or radionuclides. TRVs for organic compounds were derived from AWQCs. Aquatic standards for radionuclides were taken from Colorado Water Quality Control Commission (WQCC) standards published for segment 5 of the Big Dry Creek basin (5 CCR 1002-8; April 1993) and were established primarily for protection of human health. The WQCC has classified segments of Woman Creek at Rocky Flats as Class 2 Aquatic Life. Class 2 streams are not capable of sustaining a wide variety of aquatic fauna due to lack of physical habitat, sufficient flow, or to uncorrectable water quality conditions (5 CCR 1002-8; April 1993).

Owing to lack of sufficient data to develop them, neither Colorado state water quality standards nor EPA AWQC were available for many of the organic contaminants. When insufficient data are available to establish an AWQC, EPA often reports a lowest-effects concentration (LEC). Chronic LECs were treated as LOELs in calculating TRVs. If only an acute LEC was available, it was divided by 8.7 a conservative estimate for acute to chronic ratio for chlorinated aliphatics (EPA, 1980), and by 3.5 (the factor required when estimating an NOEL from an LEC).

It should be stressed that neither the TRV nor the EECs are action levels. They are merely benchmark concentrations for evaluating the potential hazard to ecological receptors at RFP. Use of the criteria in risk characterization is discussed in Section E8.

E5.1.2 Ecological Effects Criteria

Ecological effects criteria (EECs) were developed using the TRVs to calculate the maximum environmental media concentrations that would result in exposure equal to the TRV. For exposure routes involving direct contact with the environmental medium, or for which the TRV is expressed in terms of exposure concentration, the TRV and the EEC were the same. For routes involving ingestion, or for which the TRV is expressed in terms of an uptake rate, the EEC was calculated from the TRV and the route-specific method for estimating exposure.

E5.1.2.1 Air in a Hypothetical Animal Burrow

Contamination of groundwater by VOCs can also affect burrowing animals through inhalation of soil gases in burrows. EECs were developed by using the ideal gas law to calculate maximum soil concentrations that would result in acceptable exposure to burrow occupants. The EECs were calculated by estimating the partial pressure corresponding to the TRV (Maughan, 1993). The corresponding soil concentrations were then calculated using Henry's Law and assuming equilibrium between soil and air within a closed burrow (see Section E6.1.4.4 for equations used in exposure calculations).

E5.1.2.2 Sediment Quality Criteria

Sediment quality criteria (SQC) were calculated for organic contaminants detected in sediments at OU1. Two methods were used, both involving use of the equilibrium partitioning approach recommended by EPA to estimate the concentration of contaminants in interstitial water (EPA, 1992c; Baudo *et al.*, 1993; Maughan, 1993). The toxicity of many sediment contaminants is correlated with the concentration of the chemical in interstitial water. The objective of the equilibrium partitioning method is to estimate contaminant concentration in the interstitial water assuming chemical equilibrium with the bulk sediment phase. For nonpolar organic contaminants the distribution between sediment and interstitial water is controlled by physical and chemical properties of the contaminant (EPA, 1992c; Baudo *et al.*, 1990). The primary properties that influence distribution are the relative hydrophobicity of the contaminant and the organic carbon content of the sediment. Relative hydrophobicity is assessed using the sediment/water partitioning coefficient (K_p) which is the ratio of the concentration of the chemical in sediment (μg/kg) to the concentration in water (μg/L). For nonpolar organic chemicals the SQC is estimated from:

Eq. E5-1

$$SQC = K_p \ x \ WQC$$

where WQC is the water quality criterion for continuous exposure (EPA, 1992c). This method was used to develop SQCs for toluene and trichloroethane in sediments at OU1. Site-specific sediment and water concentrations were used to estimate K_p (Table E5-1A).

The particulate organic carbon content of sediments has an important effect on the relative K_p of organic chemicals in sediments. EPA has used the equilibrium partitioning approach to develop interim SQC for a limited number of organic contaminants, including some PCBs and PAHs. The criteria are expressed as the mass of contaminant per mass of organic carbon and thus can be calculated on the basis of site-specific measurement of particulate carbon in soils or sediments. Development of a site-specific SQC for PAHs and PCBs detected at OU1 was accomplished using these criteria (Table E5-1B).

E5.1.2.3 Maximum Allowable Tissue Concentrations

A MATC is the lowest tissue concentration that correlates with sublethal adverse effects. MATCs are presented in units of total contaminant per unit body weight on a whole body basis. MATCs were calculated for radionuclides and PCBs using methods specific to each contaminant to determine the risk to populations of potential receptors. Methods used to estimate MATCs are chemical-specific and are described in the toxicity assessment for each chemical (Section 5.2). Tissue samples from OU1 were analyzed for selenium, plutonium, americium, and uranium, and the results were compared to the MATCs in the exposure assessment and risk evaluation. The presence of PCBs at OU1 had not been documented prior to Phase III field activities. Because biological investigations were scheduled to take place prior to completion of abiotic activities, the need to analyze biota tissues for PCBs was not anticipated. Therefore, PCB body burdens and the MATCs for top predators were estimated from bioaccumulation models.

MATCs were also used in conjunction with contaminant-specific and pathway-specific exposure parameters to estimate EECs for soils. Methods for use of MATCs are discussed in the toxicity assessment for individual COCs.

E5.1.2.4 Estimation of Soil Criteria for Biomagnification Pathways

The EECs for exposure to PCBs in soils were calculated using the estimated bimagnification potential and MATC (Fordham and Reagan, 1991). Use of this method was specified in the EEW (DOE, 1991a) and requested by EPA. The biomagnification potential of PCBs was estimated using a method adapted from Thomann (1981) and Fordham and Reagan (1991). The method estimates the potential bioaccumulation in select food chains that are components of a local food web. The method utilizes literature values for bioaccumulation of PCBs from soils and adjusts the total intake of upper consumers according to a site use factor and the area in which PCBs were detected. Biomagnification is estimated as:

Eq. E5-2

$$BMF_i = BAF_i + f_i(BAF_{i-1}) + f_{i-1}\,(BAF_{i-2}) + \ldots + (BAF_1)$$

where:

BMF_i = biomagnification factor for level i

BAF_i = bioaccumulation factor for level i

f_i = "food term" for level i

The subscript i refers to the (trophic) level in the food chain. Level 1 refers to the species at the base of the food chain that accumulate contaminant primarily from direct contact with contaminated media. The BAF for level 1 is equal to the bioconcentration factor (BCF) for absorption of the contaminant from environmental media.

The "food term" is incorporated to adjust the concentration factors for daily ingestion rate, assimilation efficiency, elimination rates, diet composition, and site use. The food term f was calculated as:

Eq. E5-3

$$f_i = \frac{a^* FIR_i^* DF^* SU}{k_e}$$

where:

a = assimilation efficiency as above

FIR_i = daily ingestion rate of food item *i* (g ingested/g body weight/da)

DF = dietary fraction

SU = site use factor as above

k_e = elimination rate for the COC (loss rate, per day)

Dietary fraction refers to the proportion of the diet represented by a particular species or group of species. In the case of predators whose diet consists of several prey species DF is set at 1 and the conservative assumption made that all of the food obtained from the OU1 area contains the same amount of contaminant. This is conservative because many of the prey species are themselves wide-ranging and experience lower exposure than the prey species used in the calculation.

It should be noted that the development of the above model was based on transfer of contaminants in an aquatic-based food web. The development of exposure models for aquatic and aquatic-based systems is more advanced than similar models for terrestrial-based food webs. One reason is that the process by which contaminants are accumulated directly from contaminated soil is more complex and not as well understood as bioconcentration of contaminants from water. However, the Fordham and Reagan (1991) model can be applied to terrestrial systems using soil-invertebrate or soil-small mammal BCFs obtained from the literature (Boucher, 1993; Paine *et al.*, 1993). These empirical measures integrate the effects of the various factors affecting uptake that are not well understood. Transfer of accumulated contaminant to upper level consumers through predation or grazing is similar in aquatic and terrestrial systems except that accumulation of contaminants directly from environmental media is not as important for terrestrial vertebrates. The model is used only to approximate exposures and EECs. The potential uncertainty associated with the use of this model is discussed with the results.

The EEC for soils was calculated using the results of the biomagnification estimate (Fordham and Reagan, 1992; Maughan, 1993):

Eq. E5-4

$$EEC = \frac{MATC}{BMF}$$

E5.2 TOXICITY ASSESSMENT FOR THE OU1 COCs

The purpose of this section is to characterize the potential toxicity of the COCs identified in Section E4 and to describe the deviation of TRVs and EECs used in risk characterization. The potential toxicity of each COC to vegetation, mammals, and birds is summarized below.

E5.2.1 Selenium

Selenium is a naturally occurring metal found in highly variable concentrations in the earth's crust. Selenium is an essential nutrient to plants and animals, and lack of adequate quantities is associated with pathogenic effects (Eisler, 1985). In general, selenium concentrations of 0.05 to 1.0 milligrams per kilogram (mg/kg) are minimal dietary intakes, but selenium can be toxic at concentrations over 5 mg/kg. Selenium poisoning is well known in the western United States, where it can accumulate naturally in arid soils or in certain species of forage plants. Anthropogenic activities such as burning of coal as fuel, dumping of coal fly ash, and irrigation also result in high ambient levels of selenium in groundwater, soils, surface water, and sediments (Eisler, 1985).

Selenium exists in four basic oxidation states. Selenate (SO_4^{-2}) and selenite (SO_3^{-2}) are water soluble and are the dominant forms in freshwater. Elemental selenium (Se^0) is stable and is relatively insoluble. Selenide (Se^{-2}) occurs in both organic and inorganic forms. The inorganic type forms insoluble precipitates and is unavailable to biota. The organic selenide forms complexes with sulfur-containing amino acid in which it substitutes for sulfur atoms. Organic selenide can be the dominant form of selenium in some aquatic systems (Maier *et al.*, 1993).

Water-borne selenium is toxic to aquatic biota at levels as low as 10 μg/L (Hermanutz *et al.*, 1993) and exerts effects through the aquatic food web at levels as low as 33 μg/g dry weight (Coyle *et al.*, 1993). Effects on invertebrates and vertebrates vary but include decreased growth, behavioral abnormalities, reproductive effects, and mortality (Coyle *et al.*, 1993; Hermanutz *et al.*, 1993). The Colorado water quality standard for the protection of aquatic life is 17 μg/L dissolved selenium for chronic exposure.

Acute (lethal) toxicity of selenium to mammals occurs at ingested concentrations as low as 3 mg/kg body weight (Eisler, 1985). Chronic effects include behavioral deficiencies, myocardial degeneration, pulmonary congestion, and changes in liver chemistry. Cattle and sheep exhibited sublethal behavioral and physiological effects at intake rates of 0.5 mg/kg body weight per day (bw/day). Domestic chickens are among the most sensitive birds. Hatching was reduced at dietary concentrations of 7 mg/kg (Ort and Latshaw, 1978). Other species may not be as sensitive. Mallard ducks exhibited low hatching success at 25 mg/kg selenite but not at lower concentrations. Decreased reproduction, physical deformities, and mortality have been observed in wild waterfowl nesting and feeding in a wildlife refuge receiving irrigation return flows containing up to 1.3 mg/L selenium (Saiki and Lowe, 1987). Effects on chick limb development were observed in organ culture experiments at sodium-selenite concentrations of 0.6 mg/ℓ in culture media (Rousseaux *et al.*, 1993).

The U.S. Fish and Wildlife Service (USFWS) recommends that natural diets for livestock and wildlife do not exceed 5 mg/kg and that drinking water contains less than 50 μg/L selenium (Tables E5-2, E5-3) (Eisler, 1985). The TRV for ingestion of selenium by birds and mammals was calculated with this understanding, assuming that it is an approximation of the NOEL and using species-specific ingestion rates. These values were adopted for the TRV without modification because they were derived to be protective of all wildlife and result from review of toxicity to several species of vertebrates.

E5.2.2 Plutonium-239,-240, Americium-241, Uranium

The radionuclides plutonium, americium, and uranium have similar properties with respect to uptake and transfer in biological systems. All three are poorly absorbed from environmental media by biota. Studies on distribution of plutonium released into semi-arid regions of the western and southwestern United States reveal that greater than 99.9 percent is present in the soils and sediments at the site (Hakonson, 1975). The proportions of total environmental plutonium associated with grass/forbs and small mammals were 8.9 x 10^{-5} and 1.5 x 10^{-9}, respectively. Of the total plutonium detected in small mammal samples, 95 percent was either adhering to the pelt or present in gastrointestinal contents. Likewise, most of the plutonium associated with plant tissue is contained in surface-adhering particles that can be removed by washing (Hakonson, 1975; Little, 1976; White *et al.*, 1981). Distribution in aquatic environments is similar to terrestrial systems in that most of the radionuclide inventory is in the sediment component or adhered to vegetation and benthic organisms (Emery *et al.*, 1975; Whicker, 1990). These general concepts appear to be true of the Rocky Flats environment, because some of the studies cited were conducted there (Johnson *et al.*, 1974; Little, 1976; Bly and Whicker, 1978; Little *et al.*, 1980).

Gastrointestinal uptake of plutonium and americium in mammals is less than 10^{-3} of the ingested concentration. True plant uptake of plutonium oxides is 10^{-4} or less of soil concentrations. Thus, very little of the released radionuclide actually enters the body of exposed biota. Once in the body, the transuranic radionuclides distribute to bone and liver tissues and are cleared slowly. However, even given the slow clearance rates, these radionuclides are not transferred via trophic interactions or biomagnification (Johnson *et al.*, 1974; Little, 1976; Hakonson, 1975; Bly and Whicker, 1978; Little *et al.*, 1980).

Typical concentrations of transuranic radionuclides in contaminated environmental media are not likely to impact biota. Fraley and Whicker (1973) found that native vegetation species in northeastern Colorado were resistant to chronic exposure to external gamma radiation at 650 rad/hour. Kitchings (1978) found that small mammals required acute exposure of 100 rads to elicit sublethal effects to reproduction and blood cell morphology and composition. The

International Atomic Energy Agency (IAEA) states that dose rates below 0.1 rad/day do not result in adverse effects in plants or animals (IAEA, 1992).

The potential toxicity of the radionuclide COCs to terrestrial biota was assessed in three ways. First, the maximum allowable dose rate, 0.1 rad/day, was used to calculate the MATC for each radionuclide COC (Table E5-4). This was done by solving the equation

Eq. 5-5

$$Dose\ (rad/day) = \frac{(tissue\ (pCi/g))(2.22\ dis/min)(effect.\ abs.dose\ (MeV/dis))(1.6 \times 10^{-6}\ ergs/Mev)(1440\ min/day)}{100\ ergs/g\text{-}rad}$$

for the tissue concentration resulting in 0.1 rad/day (Whicker, 1993). This allows direct comparison of site concentrations to the MATC.

Second, a maximum allowable ingestion rate was calculated using the MATC and solving Eq. E5-6 (see below) for the COC ingestion rate that would result in the MATC.

Eq. E5-6

$$Tissue\ Concentration = \frac{C_f\ x\ FIR\ x\ a}{BW\ x\ k_e}\ x\ (1-e^{k_e t})$$

where:

C_f = concentration in food (mg/kg)

FIR = ingestion rate (kg/day)

a = assimilation efficiency

BW = body weight (kg)

k_e = coefficient of elimination (per day)

t = time (days)

This step allows comparison of ingestion rates calculated for the entire OU1 area to a maximum permissible rate (Table E5-5).

Third, an EEC for soils was calculated using the MATC and solving Eq. E5-6 for the maximum radionuclide concentration in food that would result in acceptable tissue concentrations (Table E5-6). The soil criterion was then calculated assuming the ratio of radionuclide concentration in deer mice and soil is 10^{-3} (Killough and McKay, 1976) (Table E5-6). This step allows identification of areas within OU1 that may exceed maximum permissible concentrations.

The potential toxicity of radionuclides to aquatic organisms can be estimated using a method adapted from Killough and McKay (1976).

Eq. E5-7

$$C_w = \frac{D_{rad}}{K \ x \ BCF \ x \ E}$$

where:

C_w = maximum allowable radionuclide concentration in water (μCi/mL)

D_{rad} = maximum allowable dose rate (mrads/yr)

K = constant $\dfrac{1.87 \times 10^{-7} \text{ g-rad}}{(\mu\text{Ci-yr})(\text{MeV-dis}^{-1})}$

BCF = bioconcentration factor (unitless)

E = effective absorbed energy (MeV)

The maximum allowable dose rate of 0.1 rad/day (36,500 mrad/year); BCFs obtained from the literature (Killough and McKay, 1976); and the appropriate E values for plutonium, americium, and uranium were used to estimate the following maximum concentrations for surface water (converted to pCi/L):

plutonium-239,-240	100 pCi/L
americium-241	34 pCi/L
uranium-238	398 pCi/L

These values are considerably above the standards set by the Colorado WQCC to protect drinking water in Segment 5 of the Big Dry Creek basin (CCR, 1993).

plutonium-239,-240	0.05 pCi/L
americium-241	0.05 pCi/L
uranium-238	5.0 pCi/L

Although they may be overprotective, the WQCC standards were adopted as TRVs for surface water (Table E5-3).

E5.2.3 1,1-Dichloroethene

As noted in Section E4, concentrations of 1,1-dichloroethene (DCE) at OU1 pose no threat to wildlife through ingestion of soil, vegetation, or water. However, elevated concentrations in shallow groundwater have the potential to impact vegetation through direct contact with roots and, possibly, burrowing mammals through inhalation of volatilized DCE in burrows.

Little information was available on the toxicity of organic solvents to vegetation species. Hulzebos *et al.* (1993) tested the effect of 76 organic priority pollutants on growth of the milky lettuce (*Lactuca sativa*). Each chemical was added to soil or nutrient solution, and EC_{50} values for effects on growth were determined. For purposes of this study, results from nutrient solutions were used to approximate effects from exposure to chemicals in groundwater. No results were available for DCEs, but the chlorinated solvents trichloroethane (TCA) and tetrachloroethene (PCE) were tested. These results were used to estimate the TRV for exposure of vegetation to DCE in groundwater. EC_{50} values for TCA and PCE in nutrient solutions were 104,000 μg/L and 12,000 μg/L, respectively. The EC_{50} value for PCE was used to calculate the TRV for DCE because it is similar to DCE in toxicity and persistence (EPA, 1979). The resulting TRV and EEC for exposure of vegetation to DCE in groundwater was 2,000 μg/L

(Table E5-3). The derivation of the TRV includes a safety factor of 6 for estimation of the NOEL from an EC_{50}.

The high concentration of DCE in groundwater could also affect air quality in animal burrows. The effect of exposure to DCE through respiratory pathways is not well known. EPA has not issued an approved reference concentration (RfC) for human exposure for lack of data (EPA, 1993). Therefore, no ecological effects level for exposure of burrowing animals could be set. However, exposure to DCE in burrow air was estimated and is presented in Section E6.

E5.2.4 Carbon Tetrachloride

As noted in Section E4, concentrations of carbon tetrachloride at OU1 pose no threat to wildlife through ingestion of soil, vegetation, or water. However, elevated concentrations in shallow groundwater have the potential to impact vegetation through direct contact with roots and, possibly, burrowing mammals through inhalation of contaminated air in burrows. No data were available on the effect of carbon tetrachloride on vegetation. The value for PCE, 2,000 μg/L was adopted because PCE is similar to carbon tetrachloride in physical characteristics and persistence in the environment (Table E5-3). EPA has not recommended an RfC for toxicity due to inhalation of carbon tetrachloride. Therefore, no TRV for inhalation could be set. However, exposure to carbon tetrachloride in burrow air was estimated.

E5.2.5 1,1,1-Trichloroethane

Like DCE, concentrations of TCA in soils and surface water do not appear to pose a threat to wildlife through ingestion of soil, vegetation, or surface water or through contact of aquatic life with surface water (see Section E4.2.10). However, localized high concentrations in groundwater may result in potential impacts to vegetation. TCA was also detected in sediments and has the potential to affect aquatic life.

Hulzebos *et al.* (1993) tested the effect of TCA on growth of *Lactuca sativa* in nutrient solutions. The EC_{50} for reduced growth was 104,000 μg/L, corresponding to a TRV of 17,000

μg/L (Table E5-3). The derivation of the TRV includes a safety factor of 6 for estimation of the NOEL from an EC_{50}.

The high concentration of TCA in groundwater could also affect air quality in animal burrows. The effect of exposure to TCE through respiratory pathways is not well known. EPA has set a chronic RfC for human exposure of 1 mg/m^3 which includes an uncertainty factor of 1,000 (EPA, 1993). The RfC is based on an no-observed-adverse-effects level (NOAEL) of 1,000 mg/m^3 for hepatotoxicity in guinea pigs after a six-month exposure to TCA (Table E5-7). Guinea pigs are among the species most sensitive to exposure to xenobiotic compounds. To derive the TRV, the NOAEL was divided by 2 to account for interspecific variation.

TCA was also detected in sediments at OU1 surface water sampling sites. Although no sediment quality criteria have been set for TCA, EPA has issued guidance on estimating acceptable concentrations of organic contaminants in sediments (EPA, 1992c). The equilibrium partitioning approach was used to estimate the maximum concentration of TCA in sediments that would result in acceptable interstitial water concentrations (Table E5-1A).

E5.2.6 Trichloroethene

Concentrations of trichloroethene (TCE) in soils and surface water do not appear to pose a threat to wildlife through ingestion of soil, vegetation, or surface water or through contact of aquatic life with surface water (see Section E4.2.1.11). Localized high concentrations in shallow groundwater could impact vegetation and burrowing mammals.

No information on the effects of TCE on vegetation were available. However, the previously noted study by Hulzebos *et al.* (1993) was used to estimate the TRV for exposure of vegetation to TCE in groundwater. The EC_{50} for the effect of PCE on growth of *Lactuca sativa* was 12,000 μg/L. Since the chemical structure of TCE is similar to PCE, this value was used to estimate a TRV. The TRV is estimated at 2,000 μg/L and includes a safety factor of 6 to account for estimation of a NOEL from an EC_{50} (Table E5-3).

The high concentration of TCE in groundwater could also affect air quality in animal burrows. The effect of exposure to TCE through respiratory pathways is not well known. EPA has not issued an approved RfC for human exposure based on a NOEL of 720 mg/m^3 for rats (Table E5-7)(EPA, 1993).

E5.2.7 Tetrachloroethene

As noted in Section E4.2.1.12, concentrations of PCE in soils, surface water, and vegetation do not appear to pose a threat to terrestrial or aquatic life. However, localized high concentrations of PCE in groundwater could impact vegetation through contact with roots or burrowing mammals through inhalation of vapors released from groundwater.

The effects of PCE on *Lactuca sativa* were investigated by Hulzebos *et al.* (1993). The EC_{50} for effects on growth of foliage was 12,000 $\mu g/L$. This value was used to calculate a TRV by including a safety factor of 6 to account for the estimation of a NOEL from the EC_{50}. The resulting TRV is 2,000 $\mu g/L$ (Table E5-3).

The high concentration of PCE in groundwater could also affect air quality in animal burrows. The effect of exposure to TCE through respiratory pathways is not well known. EPA has not issued an approved RfC for human exposure because of lack of data (EPA, 1993). Therefore, no ecological effects level for exposure of burrowing animals could be set.

E5.2.8 Toluene

Toluene was considered a contaminant of groundwater, soils, and sediments at OU1. As noted in Section E4.2.1.13, maximum levels detected in soils and groundwater appear to pose no threat to wildlife ingesting soils or vegetation at the most contaminated locations within OU1. There also appears to be no risk to vegetation growing in contaminated groundwater as the toxic values for exposure of *Lactuca sativa* to toluene in soils and nutrient solutions are well above maximum concentrations detected at OU1.

The systemic effects of toluene include decreased growth rate, embryotoxicity, and pathologies of the lung, kidney, and liver. Increased embryotoxicity was observed in mice fed 260 mg/kg bw/day toluene. EPA reports a NOAEL of 223 mg/kg-day for hepatotoxicity in mice through ingestion of toluene. This value was divided by a factor of two to account for interspecific variation in rodents, resulting in a TRV of 111 mg/kg-day (Table E5-2). Inhalation of volatilized toluene can result in similar systemic effects. The TRV for inhalation of toluene is 320 mg/m^3, based on induction of hepatic cancer in rats. The effects criterion is based on the soil concentration that would result in this concentration in air inside a hypothetical animal burrow is 0.5 mg/kg (Table E5-3).

Toluene was also detected in sediments at OU1 surface water sampling sites. Although no interim SQC has been set for toluene, EPA has issued guidance on estimating acceptable concentrations of organic contaminants in sediments (EPA, 1992c, see Methods). The equilibrium partitioning approach was used to estimate the maximum concentration of toluene in sediments that would result in acceptable interstitial water concentrations (Table E5-1A).

E5.2.9 Polynuclear Aromatic Hydrocarbons

Eight PAH compounds were detected in environmental media at OU1: pyrene, phenanthrene, fluoranthene, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(ghi)perlene, and benzo(k)fluoranthene. Little information is available on the environmental effects of any single PAH. Smaller unsubstituted PAHs such as pyrene, fluoranthene, and anthracene may have acute toxicity or sublethal effects but are not carcinogenic. Larger substituted forms have little acute toxicity but tend to be carcinogenic. The apparently lower toxicity of the larger forms may be due to their high hydrophobicity and corresponding low bioavailability (Eisler, 1987). A wide variety of animals rapidly metabolize and/or excrete PAHs after ingestion. Most PAHs are poorly absorbed from the gastrointestinal tract, and thus a large portion is eliminated with feces. Absorbed PAHs are rapidly metabolized to varying degrees by a wide variety of animals. Despite high hydrophobicity, PAHs do not tend to accumulate in mammalian adipose tissue. Therefore biomagnification is not likely to be an important environmental pathway in terrestrial systems but may be important in aquatic-based food webs (Eisler, 1986). Most higher plants can metabolize many PAHs and are resistant to toxic effects (Eisler, 1986).

The effects of PAHs include non-carcinogenic effects on gametogenesis, red blood cells and blood chemistry, and immune function (Eisler, 1986). Carcinogenic effects on animals include epithelial tumors and lesions in gastrointestinal, hepatic, and dermal tissues (Eisler, 1987). Administered doses causing documented effects to mammals range from less than 10 mg/kg to 500 mg/kg (Table E5-8).

TRVs and EECs for exposure to PAHs were developed according to the methods described in Section E5.1. Criteria were developed for ingestion and direct (dermal) contact with soils and sediment (Tables E5-2 and E5-3).

The PAHs pyrene, phenanthrene, fluoranthene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in sediments of the SID. Interim sediment quality criteria were available for pyrene, phenanthrene, and fluoranthene (EPA, 1988b, 1991 a, b) and were used to calculate site-specific SQC using the total carbon content measured in soils at OU1 (Table E5-1B).

E5.2.10 Polychlorinated Biphenyls

The general term PCBs includes numerous homologs and congeners that vary in the number and arrangement of chlorine molecules attached to the biphenyl rings. The larger, most highly chlorinated forms are the most hydrophobic and most resistant to biodegradation and therefore tend to bioaccumulate. Distribution among tissues and the tendency to bioaccumulate are highly dependent upon the configuration of chlorine molecules on phenyl ring structures (Borlakoglu *et al.*, 1991). Bioaccumulation is most likely for contamination in aquatic habitats, because aquatic organisms tend to accumulate hydrophobic contaminants to a greater extent.

PCBs can have acute lethal effects in high concentrations (600 to 1,500 mg/kg), but chronic sublethal effects are more important ecologically. Lower concentrations tend to be more widely distributed, affecting a larger number of individuals and species (Eisler, 1986). The effects of the PCB Aroclor 1254 have been the most widely studied. Chronic exposure of mammals to concentrations as low as 0.64 mg/kg in the diet have been shown to affect reproduction. The mink, *Mustela vison*, is the most sensitive vertebrate species tested. Exposure to this concentration in the diet for 6 months resulted in reduced reproduction and death (Platonow and

Karstad, 1973). Ringer *et al.* (1972) found that a dietary concentration of 1 mg/kg resulted in reproductive impairment in mink fed for 4 months. Birds appear to be somewhat more resistant to the effects of PCBs. Reproductive failure occurs at dietary concentrations of 5 to 10 mg/kg, with domestic chickens being the most sensitive species tested (Tori and Peterle, 1983; Heinz *et al.*, 1984; Eisler, 1986). PCBs do not appear to affect vegetation species at environmental concentrations that adversely impact animals, nor do plants accumulate PCBs to the extent that animals can (Eisler, 1986).

Result of field and laboratory studies indicate that terrestrial invertebrates take up PCBs from environmental media. Since terrestrial invertebrates are a main food source for many vertebrates they may also serve as a point of entry for introduction of PCBs into the terrestrial food web. Soil-invertebrate BCFs range from 0.29 to 11.5 for earthworms (Boucher, 1993) and 0.1 to 0.2 for crickets (Paine, 1993).

Little information is available on total PCB body burdens that result in toxic effects (Eisler, 1986; Waid, 1986). This is important because even low daily ingestion rates may, over time, result in toxic levels of PCBs in tissues. However, toxic body burdens are difficult to define because congeners are assimilated, metabolized, and eliminated at different rates (Borlakoglu *et al.*, 1991). As noted previously, the presence of PCBs at OU1 was not anticipated when the analyte suite for tissue analysis was developed and, therefore, no data on PCBs in biological tissues were available. Therefore, the MATC for PCBs in vertebrates and estimates of PCB concentration in tissues of OU1 receptors were calculated using Eq. E5-6.

The risk from exposure of terrestrial receptors to PCBs was assessed using three approaches. The first approach involved the use of the bioaccumulation model described above to estimate potential magnitude of PCB accumulation in biological tissues which was, in turn, used to calculate the EEC for soils using Eq. E5-4. The second approach was to estimate the potential tissue concentrations that might result from ingestion of PCBs at OU1. The third method was to estimate a critical ingestion rate above which toxic effects might be expected.

The first approach assumed that contaminant movement in the local systems was at steady state and used Eq. 5-2 and Eq. 5-3 to estimate the potential magnitude of PCB bioaccumulation in several local food chains (Thomann, 1981; Fordham and Reagan, 1991). The value for accumulation was then used to calculate an EEC by dividing the MATC the estimated bioaccumulation factor for the site (Eq. E5-4) (Fordham and Reagan, 1991; Maughan, 1993).

The model was used to estimate potential PCB bioaccumulation in several aquatic and terrestrial food chains which are components of the local food web (Table E5-9). The food chains modeled included those that are entirely aquatic, those in which aquatic prey are taken by terrestrial predators, and those that are entirely terrestrial. The proximal source of PCBs in aquatic-based food chains is primarily contaminated sediment; soils is the main source for terrestrial food chains.

Bioconcentration from soil by invertebrates and deer mice was approximated using data from PCB-contaminated sites (Kreis *et al.*, 1987; Boucher, 1993; Paine *et al.*, 1993). The highest bioaccumulation factor for a terrestrial-based food chain was 0.88 and was estimated from the earthworm → deer mouse → owl food chain (Table E5-9). This estimate assumes that the deer mouse obtains all of its food from the OU1 area and to have a dit that includes 9 percent earthworms or other invertebrates with the balance consisting of primarily vegetation (see Attachment E-1). It is assumed that the great horned owl obtains all of its food from the OU1 area and that its diet consists mainly of small mammals. The EEC for soil was then calculated to protect the highest level in this food chain (owls) by dividing the MATC by 0.88 (see Eq. E5-4). The resulting soil criterion was 0.70 mg/kg (Table E5-3).

The allowable tissue concentration for terrestrial vertebrates was based on the sublethal toxicity of Aroclor 1254 to mink ingesting a diet containing 0.64 mg/kg for 6 months (Platonow and Karstad, 1973). The resultant body burden of PCB in mink was estimated using Eq. E5-6. The calculation assumes that the average mink weighs 0.925 kg and ingests approximately 30 g/kg bw/day (Nagy, 1987). The elimination rate (k_e) was calculated from biological half-life estimations for PCBs (Goldstein *et al.*, 1974). The value used, 0.005/day, was calculated from a half-life of 125 days for clearance of PCBs in Japanese quail (Hamdy and Gooch, 1986). The value for Japanese quail was used because it was the longest whole-body half-life estimate available for terrestrial vertebrates. Other available biological half-life estimates were determined for specific tissues and tended to be much shorter. The allowable body burden estimated from this method was 0.6 mg/kg bw.

The validity of the EEC for soils was checked using Eq. E5-5 to calculate the soil concentration that would result in a body burden of 0.6 mg/kg after 365 days of exposure assuming constant ingestion rate. This value was calculated for three main predators (coyotes, great horned owls, and red-tailed hawks) and assumed that the BCF for transfer of PCBs from soil to prey was 0.09 (Boucher, 1993). The resulting soil criteria were slightly higher than 0.19 mg/kg but within about 0.5 mg/kg of the value calculated through use of the biomagnification model (Table E5-6).

The second method was to assess the potential PCB body burdens resulting from exposure at OU1 using Eq. 5-5 and Latin hypercube simulation (see Section E6.1.4.2 for explanation of simulation modeling). Site soil data, estimated ingestion rates, and biological half-life estimates from the scientific literature were then used to estimate the accumulation rate and potential PCB body burdens after a 1-year exposure (see Table E6-17). For purposes of this calculation, it was assumed that the receptors obtained all of their food from OU1. This is a conservative assumption since most of the large predators forage in much larger areas. These estimates could then be compared to the maximum allowable body burden estimated above. The Latin hypercube simulation was then used to estimate the probability that the body burden for a given receptor would exceed the maximum allowable concentration.

The third approach was to derive an ingestion rate that would be protective of receptors consuming food or abiotic media contaminated in the PCBs. The methods described earlier were used to derive a TRV from the mink study of Platonow and Karstad (1973). The dietary concentration of 0.64 mg/kg was reduced by a factor of 3.5 for estimation of an NOEL from an LOEL, resulting in a TRV of 0.18 mg/kg in the diet. This value was then used to calculate the corresponding ingestion rates for each receptor species (see Section E6).

The bioaccumulation analysis also showed that raccoons feeding in the SID might accumulate high levels of PCBs due to contamination of sediments (Table E5-9). Using this pathway the sediment criterion calculated by the method of Fordham and Reagan (1991) was 2.1×10^{-12} μg/kg. However, this was considered a minor pathway at OU1 because of the limited area of

PCB contamination in sediments and the inconsistent availability of aquatic prey from these sites. It is included in the analysis as a potential exposure point and the risks are discussed separately.

The EEC through aquatic systems was estimated using EPA's interim SQC of 19.5 μg/kg carbon (Table E5-1B). A site-specific criterion was calculated using the total organic carbon content of soils at OU1 (EPA, 1992c; 1992; Baudo *et al.*, 1993; Maughan, 1993). EPA included consideration of bioaccumulation of PCBs in aquatic food chains in development of the interim sediment criterion. Thus, the site-specific criterion calculated from the interim SQC includes biomagnification.

Table E5-1

Sediment Quality Criteria (SQC) for OU1 Environmental Evaluation

A. Toluene and Trichloroethane

Compound	Maximum OU1 Surface Water Conc. (μg/L)	Maximum OU1 Sediment Conc. (μg/kg)	Kp[a] (L/kg)	Surface Water TRV (μg/L)	Estimated Sediment Quality Criterion[b] (μg/kg)
Toluene	5	8	1.60E+00	500	800
1,1,1-TCA	4	7	1.75E+00	604	1,057

[a] Sediment/water partitioning coefficient calculated from site data

[b] Method according to USEPA 1992

B. PAHs and PCBs

Compound	Interim Sediment Quality Criterion[a] (mg/kg carbon)	OU1 Sediment Carbon Conc. (μg C/g sediment)	Sediment Qualtiy Criterion Normalized to Site Carbon (μg/kg sediment)	Mean Sediment Concentration at OU1 (μg/kg)[b]	Site Conc./SQC (unitless)
Pyrene	1,311	14,523	19,665	220	0.01
Phenanthrene	123	14,523	1,845	260	0.14
Fluoranthene	1,022	14,523	15,330	220	0.01
Benzo(b)fluoranthene	na	--	--	260	--
Benzo(k)fluoranthene	na	--	--	250	--
Aroclor-1254	20	14,523	292.50	119	0.41

[a]USEPA 1988, 1991

[b]Site mean calculation uses one-half of detection limit. Maximum detected concentration is less than mean shown.

na = no criterion available

Table E5-2

Toxicity Reference Values for Ingestion, Inhalation, and Dermal Exposure Routes

Pathway	Ingestion		Inhalation	Dermal
COC	Birds (mg/kg/day)	Mammals (mg/kg/day)	Mammals (mg/cu. m)	Mammals (mg/kg)
Selenium	5 mg/kg diet	5 mg/kg diet	--	--
Plutonium-239,-240	0.1 rad/day[a]	0.1 rad/day	--	--
Amercium-241	0.1 rad/day	0.1 rad/day	--	--
Uranium	0.1 rad/day	0.1 rad/day	--	--
Carbon Tetrachloride	--	--	--	--
1,1,1-Trichloroethane	--	45	500	nd
Trichloroethene	--	200	720	nd
Tetrachloroethene	--	7	na	nd
1,1-Dichloroethene	--	2.6	na	nd
Toluene	--	--	320	nd
PAHs				
Pyrene	nd	nd	nd	nd
Phenanthrene	nd	nd		2,428
Fluoranthene	250	250	280	nd
Benzo(a)pyrene	10	10	0.34	0.3
Benzo(a)anthracene	500	500	nd	11.6
Benzo(ghi)perlene	nd	nd	nd	nd
Benzo(b)fluoranthene	40	40	2.9	99.2
Benzo(k)fluoranthene	72	72	2,820	436.4
PCBs (Aroclor-1254)	1.4	0.18	--	--

[a]Based on total body dose

nd = no data

-- not a COC for this pathway

Table E5-3

Ecological Effects Criteria for OU1 Environmental Evaluation

Pathway	Direct Contact		Direct Contact		Ingestion		Inhalation	Dermal
	Aquatic Species		Vegetation					
COC	Water (μg/L)	Sediment (μg/kg)	Soil (μg/kg)	Groundwater (μg/L)	Herbivores (mg/kg)	Carnivores (mg/kg)	Mammals (mg/kg)	Mammals (mg/kg)
Selenium	--	--	--		5 (in diet)	5 (in diet)		
Plutonium-239,240	0.05 pCi/L	--	--	--	0.1 rad/day[a]	0.1 rad/day		
Amercium-241	0.05 pCi/L	--	--	--	0.1 rad/day	0.1 rad/day		
Uranium	5 pCi/L	--	--	--				
Carbon Tetrachloride				2,000				
1,1,1-Trichloroethane	604	1,060[b]	166,000	17,000			0.4	--
Trichloroethene	--	--	166,000	2,000			0.75	--
Tetrachloroethene	--	--	166,000	2,000				--
1,1-Dichloroethene	--	--	166,000	2,000				--
Toluene	500	800[b]					0.57	--
PAHs								
Pyrene	--	1,050[c]						
Phenanthrene	--	98[c]						466
Fluoranthene	--	818[c]						
Benzo(a)pyrene	--	--			10	10		0.3
Benzo(a)anthracene	--	--						
Benzo(b)fluoranthene	--	--						19
Benzo(ghi)perlene	--	--						
Benzo(k)fluoranthene	--	--			79.8			
PCBs	0.014	15.6[c]			6.7	0.13	--	--

[a]Based on total body burden

[b]Calculated using maximum surface water and sediment concentrations detected on-site because mean concentrations included >95% non-detects. Calculation methods according to USEPA (1992).

[c]Calculated using interim sediment criteria set by USEPA (1988).

-- not detected or not a contaminant for this medium

Table E5-4

Maximum Allowable Tissue Concentration (MATC) for Radionuclides[a]

Radionuclide	Maximum Allowable Whole Body Dose (rad/day)	Effective Absorbed Dose[b] (MeV/dis)	Maximum Allowable Tissue Concentration (pCi/g)
Plutonium-239,-240	0.10	53	36.8
Americium-241	0.10	57	34.3
Uranium (total)	0.10	49	40

[a]MATC calculated by solving Eq. E5-5 for the tissue concentration that results in a dose rate of 0.1 rad/day

[b]Values from Killough and McKay (1976)

Table E5-5

Calculation of Critical Radionuclide Ingestion Rates for a Three-Year Exposure[a]

Radionuclide	COC Ingestion Rate (pCi/kg bw/day)	Biological Half-life[b] (days)	k_e (L/day)	t (days)	MATC (pCi/g)
Plutonium	0.034	65,000	1.1E-05	1,095	37
Americium	0.032	20,000	3.5E-05	1,095	34
Uranium	0.28	100	6.9E-03	1,095	40

[a]Ingestion rates were calculated by solving Eq. E5-5 for the COC ingestion rate that would result in the MATC

[b]Values from Killough and McKay (1976)

MATC = maximum allowable tissue concentration

Table E5-6

Soil COC Concentrations that Result in Allowable Tissue Burdens[a]

Contaminant	Species	Predicted Soil Concentration Conc.	C_f (mg/kg)	Food Ingestion Rate (FIR) (kg/day)	a	Mass (kg)	Biological Half-life (days)	k_e (L/day)	t (days)	Max. Allowable Body Burden (mg/kg bw)
Plutonium	Deer Mouse	6.00E+05	6.00E+02	0.0032	0.001	0.019	65,000	1E-05	365	3.68E+01
Americium	Deer Mouse	5.61E+05	5.61E+02	0.0032	0.001	0.019	20,000	3E-05	365	3.43E+01
Uranium	Deer Mouse	1.79E+06	1.79E+03	0.0032	0.001	0.019	100	0.0069	365	4.00E+01
PCBs (total)	Red-tailed Hawk	0.37	0.033	0.14	0.9	1.1	125	0.0055	365	0.595
	Great Horned Owl	0.43	0.039	0.16	0.9	1.5	125	0.0055	365	0.59
	Coyote	0.69	0.062	0.81	0.9	12	125	0.0055	365	0.59

[a]Calculated by solving Eq. E5-5 for C that results in maximum allowable a body burden after a 365-day exposure, calculating soil values assuming the BCF for transfer of contaminant from soil to small mammals is 0.001 and 0.09 for radionuclides and PCBs, respectively (Killough and McKay, 1976; Boucher, 1993)

Table E5-7

Soil Effects Levels for Volatile Organic Compounds in Burrow Air

Compound	TRV (mg/cu. m)	Effects Level (atm)	Effects Level in Soil (mole/cu. m) = Vcd/H	Effects Level in Soil (mg/kg)
Toluene	320	7.99E-05	1.23E-02	0.57
Trichloroethene	720	1.26E-04	1.14E-02	0.75
Trichloroethane	1,000	1.72E-04	5.90E-03	0.39

Table E5-8

Chronic Sublethal Toxicity of PAHs to Mammals[a]

PAH	Ingestion		Dermal	
	Dose (mg/kg)	Effect	Dose (mg/kg)	Effect
Pyrene	nd	--	nd	--
Phenanthrene	nd	--	71	Cancer
Fluoranthene	250	Fetal Toxicity	280	Cancer
Benzo(a)pyrene	10	Fetal Toxicity	0.05	Cancer
Benzo(a)anthracene	500	Cancer	0.34	Cancer
Benzo(b)fluoranthene	40	Cancer	2.9	Cancer
Benzo(ghi)perlene	nd	--	nd	--
Benzo(k)fluoranthene	72	Cancer	2820	Cancer

[a]Data as cited in Eisler (1987), Kappleman (1993), USEPA (1993)

nd = not detected

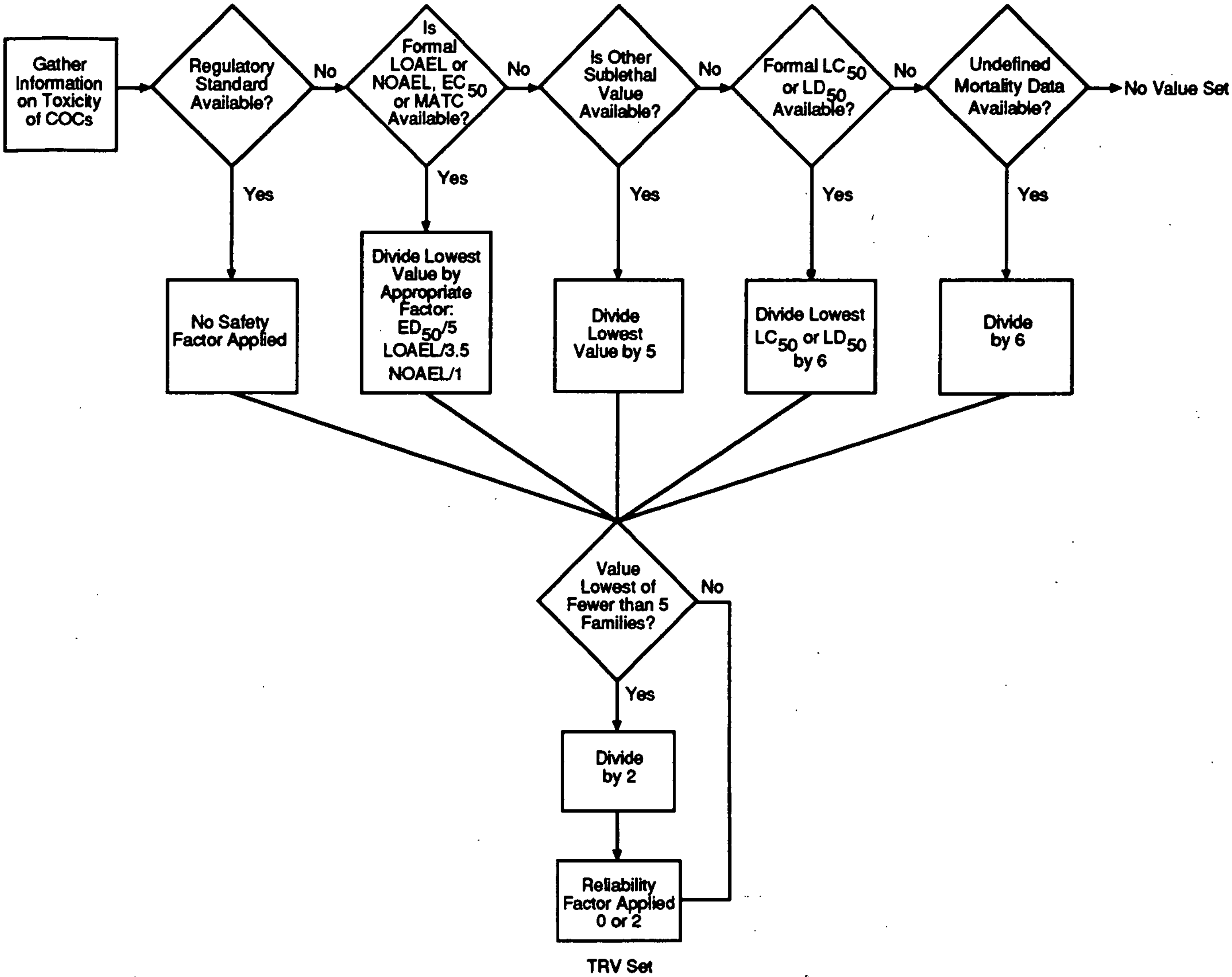
Table E5-9

Potential Bioaccumulation Factors for Uptake of PCBs at OU1[a]

Trophic Level	Species	Assimilation Efficiency	Dietary Intake (g/g bw/day)	Loss Rate (per day)	Dietary Fraction (unitless)	Site Use Factor (unitless)	Food Term	BCF_i[b]	BAF_i
Aquatic-Based Food Web									
Level 1	Crayfish	0.9	--	--	--		--	1.00E+05	--
Level 2	Raccoon	0.9	0.025	0.006	0.5	0.5	9.38E-01	0	9.38E+04
Level 1	Microcrustacean	0.9	--	--	--		--	1.00E+05	--
Level 2	Fathead	0.9	0.03	0.01	1	1	2.70E+00	3.89E+04	3.09E+05
Level 3	Bass	0.9	0.03	0.00075	0.5	1	1.80E+01	3.89E+05	5.95E+06
Level 1	Microcrustacean	0.9	--	--	--		--	1.00E+05	--
Level 2	Fathead	0.9	0.03	0.01	1	1	2.70E+00	3.89E+04	3.09E+05
Level 3	Heron	0.9	0.057	0.006	0.5	0.25	1.07E+00	0.00E+00	3.30E+05
Level 1	Microcrustacean	0.9	--	--	--		--	1.00E+05	--
Level 2	Fathead	0.9	0.03	0.01	1	1	2.70E+00	3.89E+04	3.09E+05
Level 3	Bass	0.9	0.03	0.00075	0.5	1	1.80E+01	3.89E+05	5.95E+06
Level 4	Heron	0.9	0.057	0.006	0.5	0.25	1.07E+00	0	1.16E+06
Terrestrial -Based Food Web									
Level 1	Earthworm	0.9	--	--	--		--	3.9	--
Level 2	Deer Mouse	0.9	0.0032	0.075	0.09	1	3.46E-03	9.00E-02	1.03E-01
Level 3	Coyote	0.9	0.07	0.006	0.9	0.1	9.45E-01	0	9.78E-02
Level 1	Earthworm	0.9	--	--	--		--	3.9	--
Level 2	Deer Mouse	0.9	0.0032	0.075	0.09	1	3.46E-03	9.00E-02	1.03E-01
Level 3	Red-tailed Hawk	0.9	0.057	0.006	1	0.1	8.55E-01	0	8.85E-02
Level 1	Earthworm	0.9	--	--	--		--	3.9	--
Level 2	Deer Mouse	0.9	0.0032	0.075	0.09	1	3.46E-03	9.00E-02	1.03E-01
Level 3	Great Horned Owl	0.9	0.057	0.006	1	1	8.55E+00	0	8.85E-01

[a]Methods according to Fordham and Reagan (1991)

[b]BCF for earthworm and deer mouse from Rhett et al. (1988) Boucher (1993)



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

881 HILLSIDE AREA
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PHASE III RFI/RI REPORT

Decision Process for Determination of Toxicity Reference Values (TRVs)

Figure E5-1

M\ES\Tox Ref Values 2.mdw\8-10

SECTION E6
EXPOSURE ASSESSMENT

The purpose of this section is to characterize the exposure of ecological receptors to potentially harmful contaminants originating from OU1 IHSSs. Exposure is composed of two basic components: (1) contact of the receptor with the contaminant in environmental media, and (2) uptake of the chemical into the organism's body (EPA, 1989c). The magnitude of the exposure is a function of the concentration of the contaminant in environmental media, the frequency and duration of contact, and the amount of the contaminant that is actually taken up by the receptor. The exposure analysis was conducted for individual organisms, and results were extrapolated to a population or community (Suter, 1993). The objective of the exposure assessment is to describe and, where possible, quantify contact and uptake of a contaminant by receptor species (Maughan, 1993).

The chemicals for which exposures were estimated were the COCs described in Section E4. Exposure was estimated only for potentially complete exposure pathways identified on the basis of site-specific data pertaining to the nature and extent of contamination, the physical structure of the site, and the ecological resources potentially at risk. Exposures were estimated for species chosen to represent major functional groups, sensitive species, or major prey taxa (EPA, 1989b, 1992a; Maughan, 1993; Suter, 1993).

The results of the exposure assessment were used in conjunction with the toxicity assessment to determine whether the exposure levels are potentially harmful. These data were then compared to the ecological effects data to determine whether predicted effects, if any, are manifested in the ecosystem.

E6.1 GENERAL METHODOLOGY FOR EXPOSURE PATHWAY ANALYSIS

E6.1.1 Identification of Pathways to be Evaluated

Exposure pathways describe the mechanisms by which contaminants are released, transported, and taken up by receptors (EPA, 1989c). The characterization of exposure pathways includes the identification of the primary source of a contaminant, the primary mechanisms by which it is released and transported from the source, the point of potential contact with ecological receptor(s) (exposure point), and the mechanism by which the contaminant is taken up by the receptor (exposure route) (EPA 1989a, c). These components can be further defined as involving primary or secondary sources and release mechanisms.

Once a contaminant has been released to the environment (primary release), it will enter an environmental medium and be transported to a point of exposure to another environmental medium, from which a secondary release and secondary exposure can occur. Primary and secondary transport can result in an expanded area of contamination and the potential for exposure of biotic receptors. The most important abiotic media—soil, surface water, and sediment—may act both as sources of direct exposure to a variety of plant and animal groups and as entry points for contaminant movement into the food web. Food web transfer can further distribute contaminants and result in concentrations at higher trophic levels. However, food web interactions are important only for contaminants that bioaccumulate, either through bioconcentration or biomagnification.

E6.1.1.1 Sources and Transport of Contaminants at OU1

The primary sources of contamination at OU1 are surficial soils within the IHSSs (Figure E6-1). Soils were apparently contaminated when liquids containing primarily organic solvents and plutonium-contaminated lathe cuttings were deposited on soils as a result of various spills or leaks. Subsequent releases of contaminants may have occurred when contaminated soils were transported away from the primary source area and deposited in downgradient areas or when contaminants were leached from soils and entered surface or subsurface waters. The result was potential secondary or tertiary sources and exposure points.

As described in Section E4, potential contaminants at OU1 were identified from analysis of historical release reports (DOE, 1992a) and site-specific data collected during Phase I, II, and III RFI/RI field investigations. This analysis is detailed in Appendix D of the Final OU1 Phase III RFI/RI Report. Results of this analysis indicated apparent contamination of surface and subsurface soils, groundwater, surface water, and sediment with radionuclides and organic compounds (Table E4-2).

This list of potential contaminants was screened for ecotoxicity and used to generate the list of COCs for the EE (Table E4-5). The process and criteria by which COCs were selected are presented in Section E4. The distribution of COCs in environmental media and the physical and toxicological characteristics of each chemical were used to identify exposure routes and exposure points for key receptors and are described in the following subsections.

E6.1.1.2 Potential Exposure Routes

Vegetation, wildlife, and aquatic organisms can be exposed to contaminants through direct contact with contaminated media (air, soil, sediment, water) or indirectly through consumption of forage or prey that have themselves been directly or indirectly exposed to contaminants. The mechanisms by which a contaminant may be taken up are the exposure routes. The main exposure routes at OU1 are ingestion of contaminants in food, soil, and water and absorption across external body surfaces (Figure E6-1).

Direct dermal exposure to contaminated soil is the main exposure route of concern for vegetation and soil invertebrates. Soil contaminants may be absorbed through the root system and distributed to aboveground plant parts. Plants differ greatly in their ability to absorb chemicals from the soil matrix and in their sensitivity to absorbed contaminants. Soil invertebrates also are subject to dermal absorption of contaminants in soil and may ingest soil during burrowing and feeding activities.

Burrowing vertebrates may also be exposed to soil contaminants during digging activities. Dermal absorption is not an important exposure route for heavy metals but may be in the case of organic chemicals. Contact with contaminated soil at OU1 is of less concern for more wide-ranging species such as deer, coyotes or birds because they spend less time in contact with the soil at OU1. However, ingestion of soil during feeding is a potential problem in areas with high concentrations of contaminants or sparse vegetation.

Inhalation of volatilized organic contaminants is a potentially important pathway for animals burrowing in areas of contaminated soil or groundwater. Volatilized organics may tend to accumulate in the restricted air space of the burrow. The young of several species spend most or all of their time within burrows and, therefore, may be subject to sustained exposures. Inhalation of VOC contaminants in ambient air in aboveground locations were not assessed because of the relatively low surface soil concentrations and because VOCs do not tend to accumulate in open air spaces.

Direct exposure to contaminated surface water is a potential exposure pathway for both terrestrial and aquatic species. Terrestrial vertebrates may ingest substantial quantities of water and become exposed to water-borne contaminants. Aquatic species are vulnerable to water-borne contaminants because they spend all or most of their lives submersed in the water and are confined to a relatively small area. The absorption of dissolved chemicals from the water column and the subsequent accumulation in internal tissues is known as bioconcentration. Dissolved metals and non-polar organic compounds resistant to metabolism are particularly subject to bioconcentration.

Rooted aquatic plants and aquatic animals that live on or in the substrate may also be exposed to contaminants in sediments. Contaminants may be absorbed as a result of direct contact with sediment particles or dissolved constituents in interstitial water. Sediment contact can be a main point for entry of contaminants into aquatic-based food webs.

Food web interactions are important for chemicals that bioaccumulate (DOE, 1991a; Fordham and Reagan, 1992). Bioaccumulation can result in toxic exposure, even when the ambient concentrations are relatively nontoxic. Bioaccumulation occurs by absorption and selective accumulation of a chemical directly from environmental media or through accumulation of contaminants ingested with food. Bioconcentration, the process of absorption and accumulation of dissolved chemicals in water, was described earlier. Biomagnification is the successive accumulation of a pollutant with increasing trophic level and is a significant mechanism of bioaccumulation for persistent organic chemicals such as chlorinated pesticides and some organo-metals such as methyl-mercury. For most contaminants, the highest bioaccumulation potentials occur in aquatic-based food web where bioconcentration from contaminated sediment or water accounts for a large proportion of the total bioaccumulation. In general, metals do not biomagnify, but many are known to bioconcentrate from direct exposure to environmental media, usually water (Martin and Coughtrey, 1982; Moriarty, 1983). Note that members of all trophic (feeding) levels may come in direct contact with contaminated media, most of the feeding relationships ultimately lead to predatory vertebrates, and terrestrial and aquatic components are interconnected.

The primary (most abundant) mammalian predators at Rocky Flats that are most vulnerable to the effects of bioaccumulation are the coyote and raccoon (DOE, 1992b)(Figure E6-2). The red-tailed hawk, great horned owl, and kestrel are the most abundant avian predators. The primary terrestrial prey species for mammalian and avian predators are mice, voles, and terrestrial arthropods. Some terrestrial predators may be exposed to surface water or sediment contaminants when they take prey, such as fish or crayfish, from aquatic habitats or feed on lower-level predators that have accumulated contaminants from their aquatic prey.

E6.1.1.3 Potential Exposure Points

The redistribution of contaminants from the primary sources in OU1 has resulted in the following potential exposure points (Figure E6-1):

- Soils in OU1 IHSSs and areas downgradient from OU1 IHSSs that may receive contaminated runoff.
- Surface water in Woman Creek, Ponds C-1 and C-2, and the SID.
- Sediment in Woman Creek, Ponds C-1 and C-2, and the SID.
- Terrestrial organisms such as mice and voles that feed on potentially contaminated vegetation and are prey for predators feeding in the potentially contaminated areas.
- Aquatic organisms such as small fish and invertebrates that may bioconcentrate contaminants from surface water and are prey for predators feeding in Woman Creek and Ponds C-1 and C-2.

Quantitative exposure assessment was limited to the pathways and exposure points listed above. Results of fate and transport modeling were not used to quantitatively estimate future exposures resulting from transport of contaminants away from the primary source areas. This was not done because:

- Data indicate little or no transport away from the originally contaminated soils, thus, exposure of terrestrial plants and animals to contaminants in soils is limited primarily to the immediate vicinity of the IHSSs.
- Contaminated soils transported downgradient by surface runoff are deposited in the SID, thus attenuating the spread of contamination. As noted previously, the SID was constructed to intercept contaminants transported from OU1 and channel flow to Pond C-2 for treatment and release.
- EPA and CDH have agreed that matters involving impacts to the aquatic ecosystem in Woman Creek are more properly addressed in OU5 investigation. The potential importance of downgradient transport of contaminants is discussed qualitatively in Sections E8 and E9.

The concentration of COCs at each of these exposure points was measured or estimated and used to evaluate the exposure to selected ecological receptors. The ecological receptors for which exposure was estimated are listed below.

E6.1.2 Identification of Key Receptor Species

E6.1.2.1 Selection Criteria

Because of the great diversity of plants and animals, it is impractical to evaluate exposures for all possible receptors. Therefore exposures were estimated for a representative group of receptors. These taxa, or key receptors, were chosen according to the following criteria:

- The taxon should occupy key positions in the local food web or be representative of key functional groups within the food web.
- Sufficient life history data are available to estimate diet composition, daily dietary intakes, and daily ingestion of water. In addition, information on seasonal habitat use and home ranges is needed to estimate the proportion of food or other resources that may be obtained from the OU1 area.

- If tissue samples were collected, site populations should be sufficient to support sampling.
- The receptors have some sociological importance, or directly affect a group that does (Suter 1989, 1993).

The key receptor groups are listed in Table E6-1, and the rationale for their selection is summarized below. The routes for which exposure was estimated are also listed. Candidate species were identified on the basis of information on documented occurrence at Rocky Flats or likelihood of occurrence based on regional wildlife information (DOE, 1992b). Life history information such as daily dietary and water ingestion rates, diet, and home range size were necessary for estimation of exposure. Life history data used in exposure estimations are presented in Attachment E-1.

E6.1.2.2 Key Receptors

<u>Vegetation</u>

No representative species have been designated because little information is available on toxicity to native species of vegetation. Instead, risks were evaluated based on community effects as evidenced by the endpoints of species richness, diversity, production, and community composition. Exposure was evaluated on the basis of data on toxic exposures to grassland plants in general. Exposure of vegetation to contaminants was estimated on the basis of direct exposure to contaminants in soils and groundwater. Risk was evaluated by comparing soil concentrations at OU1 to concentrations known to result in sublethal toxicities (see Section E5 Toxicity Assessment).

<u>Small Mammals</u>

Mice, voles, and other small rodents are important components of the terrestrial prey base at Rocky Flats (DOE, 1992b). The deer mouse (*Peromyscus maniculatus*), meadow vole (*Microtus pennsylvanicus*), and prairie vole (*M. ochrogaster*) were selected to represent this group. They were chosen because they are ubiquitous at Rocky Flats and are major prey sources for avian and mammalian predators. Thus, mice and voles were assessed both for exposure to contaminants and as exposure points for predators. Their home ranges are such that individuals captured within OU1 are likely to have spent most of their lives there. Exposure of these species was evaluated by estimating contaminant uptake through ingestion of vegetation and terrestrial arthropods. Mice and voles obtain water primarily from condensation on vegetation (dew) and from metabolic production of water from food. Therefore, exposure to contaminants in surface water is not a potentially complete pathway and was not assessed. Organic contaminants in soil may volatilize and accumulate in animal burrows. Therefore, the potential for exposure to contaminants in burrow air was also assessed. Specimens of these species were collected for tissue analysis to evaluate the potential for bioaccumulation of metal and radionuclide COCs to toxic levels. These data were also used to estimate exposures to predators and to evaluate the bioaccumulation of contaminants.

Mule Deer

Mule deer (*Odocoileus hemionus*) are widespread at Rocky Flats, are year-round residents, and the most abundant large herbivore at the site (DOE, 1992b). Estimates of exposure of mule deer to OU1 contaminants was made on the basis of ingestion of vegetation in the OU1 IHSS area and surface water from Woman Creek, the SID, and Pond C-1. Potential exposure to OU1 contaminants is proportional to the amount of time deer spend in the OU1 area and the activities they engage in there. For purposes of exposure assessment, it was assumed that the amount of time deer spend in the OU1 area was directly proportional to the fraction of their home range that OU1 represents. The exposure assessment also assumes that deer spend 100 percent of their time in OU1 engaged in activities resulting in exposure through the pathway being assessed (i.e., ingestion of water or food). This is a conservative assumption because deer may not use the area exclusively for foraging. These general assumptions were also made for other wide-ranging species discussed below.

Coyote

Coyotes (*Canis latrans*) are the most important mammalian predators at Rocky Flats (DOE, 1992b). Primary prey include the small mammal species listed above. Coyotes were chosen in part because they are a top predator in the terrestrial food web and there is a resident population at Rocky Flats. Exposure estimates were made on the basis of ingestion of prey and water from the OU1 area. Coyotes are usually born and spend the early part of their lives in burrows. While it is unlikely that coyotes would choose OU1 IHSS areas for this purpose, the potential for exposure to volatile contaminants in burrow air was assessed. As with mule deer, the average home range of coyotes is larger than the OU1 area, and exposure estimates were adjusted accordingly.

Red-tailed Hawk

The red-tailed hawk (*Buteo jamaicensis*) also is a top predator at Rocky Flats and is a summer resident (DOE, 1992b). Male-female pairs were often observed over Rocky Flats, and young were successfully reared at a nest along Smart Ditch Creek in the southern part of the Buffer Zone in 1991. The primary prey of red-tailed hawks are small mammals and snakes. Exposure estimates were made on the basis of ingestion of prey; mice and voles constitute all of the prey taken from OU1. The foraging range of red-tailed hawks is larger than OU1 and exposure assessment was adjusted accordingly.

Great Horned Owl

The great horned owl (*Bubo virginianus*) is a common avian predator at Rocky Flats (DOE, 1992b). The owls are nocturnal predators and feed primarily on small mammals such as voles, deer mice, and rabbits. Exposure of great horned owls to OU1 COCs was evaluated on the basis of ingestion of voles and deer mice. Great horned owls were chosen in part because their average home range size is smaller than OU1, and all prey are assumed to be taken from that area.

Species of Special Concern

Bald Eagle

Occurrence of the bald eagle (*Haliaeetus leucocephalus*) at Rocky Flats is rare. However, a pair attempted to nest a few miles east of Rocky Flats in 1993. Fish are the preferred prey of bald eagles, but they are known to consume ducks, prairie dogs, and carrion. Although its occurrence is rare at Rocky Flats, the bald eagle is federally listed as endangered; risks due to ingestion of prey from the OU1 area were therefore evaluated. Prey resources for eagles were essentially lacking in OU1, and only a qualitative assessment of potential impacts to habitat quality was included in the risk characterization.

Preble's Jumping Mouse

The Preble's jumping mouse (*Zapus hudsonius preblei*) is a federal Category 2 species currently being considered for protection (see Section E2.2.3). This subspecies of the meadow jumping mouse has been identified from the Woman Creek drainage. Exposure of this subspecies was estimated from ingested vegetation and water. Specific exposure points and exposure routes were identified for each key receptor species. Summaries of the exposure points and exposure routes for key receptors are presented in Table E6-2.

E6.1.3 Exposure Units and Data Aggregation

The exposure unit describes the area and/or data set upon which the exposure estimate is based. The exposure unit can vary with the area suspected of contamination and properties of the chemical under evaluation. It can also vary with the size and behavioral characteristics of the receptor and the specific natural resources available in the study area.

The largest exposure unit for the OU1 EE is the area defined by abiotic sampling during RFI/RI activities. Abiotic sampling within the OU1 area was focused in IHSSs, although some sampling was conducted in areas outside the IHSSs. Therefore, the suspected source areas are over-represented in the resulting data set and mean contaminant concentrations are biased upward.

The data used to evaluate exposure to contaminants in abiotic media were the OU1 sitewide mean values calculated in the "nature and extent" component of the report (see Volume I and Appendix D, OU1 Phase III RFI/RI Report). As agreed to by EPA, CDH, DOE, and EG&G, this exposure unit will be applied in exposure estimates for all vertebrate receptors (see meeting minutes for May 13, 1993). This exposure unit was deemed appropriate because exposure of mobile organisms is integrated across the areas that they use. Large, wide-ranging key receptors identified in the previous section have home ranges that are much larger than individual OU1 IHSSs, and therefore the assumed use of IHSS and non-IHSS areas is proportional to the relative areas within OU1. Exposure to smaller or less wide-ranging species such as mice, voles, and great horned owls was assessed assuming that they obtain all of their resources from the OU1 area.

Exposure to contaminants via ingestion of contaminated vegetation or animal tissue was assessed using sitewide mean concentrations. The exposure point concentration used for contaminants in vegetation was a composite mean of all tissue samples collected (see Section E7 for tissue collection methods). Likewise, the mean contaminant concentration in small mammal tissue was assessed by combining all deer mouse, meadow vole, and prairie vole samples. Diet analysis performed for key receptors indicates that small mammals are taken in proportion to the local abundance. The small mammal species listed above are by far the most abundant at Rocky Flats (see Section E2).

An exception to the use of the sitewide exposure unit the case of vegetation. Evaluation of the exposure of vegetation was performed on a sample site basis, using data from monitoring wells and boreholes to identify areas of OU1 that might have concentrations of contaminants in soils or groundwater that could lead to unacceptable exposures. The assessment of possible exposure of mammals to contaminants in burrow air was calculated on a similar basis using soil contaminant levels to identify areas in which the air of hypothetical burrows could be toxic (see Section E6.1.4).

Exposure due to contamination of surface water or sediments was also estimated on a site-by-site basis because of the varying quality of aquatic habitat in and around OU1. For example, contaminants were detected in sediments of the SID, but the SID provides extremely poor habitat and has been subjected to severe physical disturbance during site investigations and installation of the French Drain during 1992.

The data used to calculate exposures were obtained from the general database used for the characterization of nature and extent of contamination and the human health risk assessment. This step was taken to ensure consistency of data use among the components of the Phase III RFI/RI. Data were used according to standard protocols and consistently with the same uses in other sections of the report. Data qualifiers were treated as follows:

- <u>"U"-qualified data for which the reported result was less than twice the Contractor Required Quantitation Limit (CRQL)</u>—the result reported was divided by two for use in calculating means

- <u>"U"-qualified data for which the reported result was more than twice the CRQL</u>—the reported result was replaced by a value equal to one half of the CRQL for use in calculating means

- <u>"J"-qualified data</u>—the reported result was used in calculating means

- <u>"B"-qualified data</u>—the reported result was used if it was more than five times the CRQL

E6.1.4 <u>Methods for Exposure Estimation</u>

Potential exposures of the key receptors to COCs were estimated for each of the indicated exposure routes. The methods for estimating exposures for each exposure route are described below. Data from soil, surface water, sediment, and biological tissue analyses were used to generate exposure estimates for the OU1 IHSS areas. The methods for ingestion and bioaccumulation were used in combination with simulation modeling to estimate the (statistical) distribution of exposures expected in the field (Bartell *et al.*, 1992; Suter, 1993). This approach allowed quantification of the uncertainty associated with the input parameters and estimation of the probability that a receptor will experience a potentially harmful exposure. Quantitative expressions of uncertainty are presented with the results in the form of standard deviations and/or estimated probabilities of exceeding critical values such as ingestion rate TRVs or EECs (see Section E5).

Data collected during field investigations were used to determine the distributions of the input parameters used in the exposure estimation methods. Parameter values were then [pseudo-] randomly sampled from the data distributions using stratified random, or Latin hypercube, procedures and used in the exposure calculation (Iman and Conover, 1981; Bartell *et al.*, 1992). This process was repeated 500 times resulting in 500 exposure estimations from that a mean and standard deviation could be calculated. The results were also used to construct a probability density function (pdf) which was used to estimate the probability of exceeding certain critical values (TRVs or ecological effects levels). Thus, the uncertainty in the input data was quantified and was expressed in the result as the probability of exceeding given critical values.

Data distributions used in the Latin hypercube sampling were estimated from frequency histograms that were constructed from data on contaminant concentrations in abiotic and biotic media. The histograms were assigned common distributions (e.g., normal, lognormal, Wiebell) based on the shape of the probability density function. The empirical distributions from OU1 data were not used because data sets were relatively small and therefore probably do not represent the true distribution (Kirchner, 1993). In general, abiotic and tissue contaminant data approximated normal or lognormal distributions. When no common distribution could not be assigned, a triangular distribution was assumed using the minimum, mean, and maximum values to define the data set. Use of the triangular distribution is recommended with small data sets or when a common distribution cannot be assigned because it results in the least biased distribution when the true distribution is unknown thus decreasing the likelihood of underestimating exposures (Tiwari and Hobbie, 1976; Bartell *et al*, 1992; Kirchner, 1993). The simulation was implemented by assigning a distribution described by the mean and standard deviation calculated from site data. The results are presented as a mean and standard deviation of the simulated exposures, a pdf constructed from the simulated results, and, where applicable, an estimate of the probability of exceeding critical values.

E6.1.4.1 Direct Exposure

Direct exposure to contaminants in environmental media was estimated from the chemical concentrations of COCs measured in soils, surface water, and sediments. Data were obtained from the following:

- Surficial and subsurface soil sampling associated with Phases I, II, and III RFI/RI sampling at OU1.
- Surface water monitoring program.
- Toxicity testing of sediment samples collected during the OU5 Phase I RFI/RI.

Data on COC distribution in OU1 soils, groundwater, and sediments were used to identify areas that exceeded EECs. The potential toxicity of exposures was evaluated by comparison with benchmark values derived from regulatory statutes and scientific literature.

Areas exceeding EECs were approximated using the Thiessen polygon method. This method assumes that the area represented by a sampling site extends half of the distance to adjacent sampling sites. The area represented by a given sampling site was identified as follows. The midpoint of a straight line between the site and an adjacent sampling site is identified. A second line is drawn which is perpendicular to the first and intersects the midpoint. This process was repeated for all surrounding sampling sites. The intersections of the perpendiculars form the corners of a polygon which in turn defines the area represented by the sampling point it encloses. The procedure was repeated for all soil and groundwater sampling sites resulting in a montage of polygons. Polygons of contaminated sites were then identified and their areas measured. Polygons of adjacent contaminated sites were joined to define a single area.

The polygon method was also used to identify areas exceeding EECs for indirect exposure pathways such as biomagnification.

E6.1.4.2 Ingestion

Exposure due to ingestion of contaminated food and water was estimated from COC concentrations measured in samples from OU1 and estimates of daily ingestion rates of food and water. Typical diet composition was derived from the literature on each of the selected species or taxonomic groups. Daily ingestion rates of food and water were either derived from the literature or scaled to organism size and estimated from equations presented in Calder and Braun (1983) and Nagy (1987). Estimates of daily ingestion of material from the OU1 area were adjusted for the proportion of time spent in the OU1 area and estimated assimilation efficiency of ingested chemical. Assimilation efficiencies were determined from the scientific literature. If no reliable estimate was available, it was assumed that 100 percent of ingested contaminant is assimilated (a = 1.0). Exposure due to ingestion was estimated using the following equation:

Eq. E6-1

$$\textit{Daily Intake (mg/kg/day)} = \frac{[((FIR * C_f)*a) + (WIR * C_w) + (SIR * C_s)] * SU}{BW}$$

where:

FIR = daily food ingestion rate (mg/day)

WIR = daily water ingestion rate (L/day)

SIR = daily soil or sediment ingestion rate (mg/day)

C_f = concentration of COC in food (mg/kg)

C_w = concentration of COC (dissolved) in water (mg/L)

C_s = concentration of COC in soil and/or sediment (mg/kg)

a = assimilation efficiency

SU = site use factor; the proportion of the daily intake obtained from the OU1 area

BW = body weight (kg)

The ingestion of chemicals in food includes the amounts obtained from major groups of food available in OU1. Total daily intake due to ingestion of multiple food sources was estimated from the equation:

Eq. E6-2

$$\textit{Total Ingestion} = (FIR_1 * C_{f1}) + (FIR_2 * C_{f2}) + \ ... (FIR_i * C_{fi})$$

where FIR_1 and C_{f1} are the daily ingestion rate of and COC concentration in food source number 1, respectively.

If literature values were not available, estimates of total daily dietary ingestion rates by birds and mammals were scaled to organism size using the following equations (Nagy, 1987):

food ingestion rate for birds (kg/day) = $(0.398 * (BW_g)^{0.850}) * 0.001$ kg/g
food ingestion rate for mammals (kg/day) = $0.0687 * (BW_{kg})^{0.822}$

Likewise, if literature values were not available for estimation of daily water ingestion, estimates were scaled to size and estimated from Calder and Braun (1983):

water ingestion rate for birds (L/day) = $0.059 * (BW_{kg})^{0.67}$
water ingestion rate for mammals (L/day) = $0.099 * (BW_{kg})^{0.90}$

The objective of the exposure assessment is to assess the exposure due to OU1 sources. The simulation method estimates the amount of contaminant obtained from OU1. The site-use factor adjustment (SU) provides a mechanism to approximate the resources obtained from the OU1 area. The OU1 ecological study area covers approximately 100 hectares (ha). Thus, a coyote with a home range of 1,000 ha would spend about one tenth (SU = 0.1) of its time in OU1. The approach also assumes that receptors use all portions of the home range equally.
Simulation modeling was carried out by substituting the actual distribution of a contaminant in biota, water, or soil at OU1 for C_f, C_w, or C_s in Eq. E6-1 and using Latin hypercube sampling to estimate a mean and standard deviation for ingestion (Bartell *et al.*, 1993). The simulation also results in a pdf which can be used to assess the likelihood of exceeding a given ingestion rate and to evaluate the uncertainty included in the estimate of the mean.

E6.1.4.3 Radiation Dose Rates

Radiation dose rates from radionuclide body burdens were calculated for small mammals and vegetation using site data and Eq. E5-5. The calculation assumes all of the radionuclide is internal and that the dose rate from internal stores is uniform. As discussed in Section E5.2.2, these are very conservative assumptions because previous investigations have shown that most of the transuranic radionuclide associated with small mammals adheres to the pelt or is contained within the gastrointestinal tract (Hakonson, 1975). Doses from radionuclides contained in gastrointestinal contents are usually adjusted downward because of the attenuating capacity (stopping power) of gut contents (see Section E5.2.2). Much of the transuranic radionuclide activity associated with plant tissue is found adhering to the surface of foliage and results from dry deposition or rainsplash.

This calculation was not made for species in higher trophic levels because tissue data were not available. However, potential body burdens were estimated using Eq. E5-6 and site-specific COC ingestion rates calculated as described in Section E6.1.4.2. Biological half-life estimates were obtained for each of the radionuclides from the literature (Killough and McKay, 1976). The resulting tissue concentration estimates were then compared to the MATC calculated in Section E5 (Table E5-4).

E6.1.4.4 Air in Burrows

The concentration of volatile contaminants in a hypothetical animal burrow were estimated using site soil data and the following equation adapted from Maughan (1993):

Eq. E6-3

$$C = \frac{(V_p \ x \ MW)}{(R \ x \ T)} \ x \ 1000 \ \mu g/g$$

where:

- C = air concentration in burrow (mg/m^3)
- V_p = partial pressure of the contaminant (atm)
- MW = molecular weight of the contaminant
- R = ideal gas law constant (m^3 atm/mole °K)
- T = the burrow temperature in degrees K; assumed to be 280.1

Vapor pressures were calculated using the concentration of the contaminant in soils and Henry's Law constant. The method assumes equilibrium between soil and air and a closed air space.

Eq. E6-4

$$V_p = H \; x \; C_{soil}$$

where:

H = Henry's Law constant

C_{soil} = concentration of the contaminant in soil

Potential contaminant concentration in burrow air was calculated using the mean and maximum soil concentrations detected at OU1.

E6.2 EXPOSURE POINT CONCENTRATIONS

Concentrations of COCs were measured or estimated for each of the exposure points identified in Section E6.1.1.3. Mean exposure point concentrations are presented in Table E6-3. These values were either compared directly to an EEC or used in conjunction with the methods described in Section E6.1.4 to calculate exposures.

E6.3 EXPOSURE ESTIMATIONS

This section presents results of the exposure estimations that were made using the methods described above. Estimated exposures are detailed by COC in Section E6.3.1. Results are then summarized by receptor in Section E6.3.2.

E6.3.1 Summary by COC

E6.3.1.1 Selenium

Selenium was identified as a contaminant only in groundwater (Table E4-2) but was retained as a COC because it can bioaccumulate, especially in aquatic systems. Site-specific data on selenium concentrations in biota, soil, and groundwater were available as a result of RFI/RI investigations and used to estimate exposure of terrestrial organisms to selenium.

Selenium concentrations in biological tissues at OU1 were not significantly different from samples collected in the Rock Creek reference area (Table E6-4). Thus, elevated groundwater concentrations at OU1 have apparently not resulted in widespread transfer of selenium in the local food web.

Selenium concentrations measured in biota samples were used to estimate the exposure of receptors through ingestion pathways using Eq. E6-1 and Latin hypercube simulation procedures as described in Section E6.1.4. The distribution of selenium concentrations in vegetation and small mammals was approximately lognormal. This distribution was used in the simulation model to represent the actual concentrations in biota at the site. Selenium in terrestrial arthropods was not distributed as lognormal or normal and therefore was modeled as a triangular distribution (Bartell *et al.*, 1993). The input parameters and mean ($\pm$ sd [standard deviation]) exposure estimates for each receptor are presented in Tables E6-5 through E6-12. The pdfs constructed from simulation results are presented in Figures E6-3 through E6-10 and Figure E6-15.

Concentrations of selenium in vegetation, terrestrial arthropods, and small mammals did not exceed the 5 mg/kg TRV for concentration in the diet of birds and mammals. The mean rate of selenium ingestion did not exceed the target or maximum allowable ingestion rate for any of the receptors assessed, and the probability of exceeding the critical value was not above 5 percent for any receptor except the great horned owl (Table E6-13 and Figure E6-9A).

The higher probability for the owl was primarily due to the assumption that it hunts entirely within OU1 (SU = 1). The simulation estimates only the amount of contaminant obtained from the OU1 area. The other predators evaluated—coyotes, red-tailed hawks, and bald eagles—hunt across areas far larger than the OU1 area, and therefore the amount of selenium potentially obtained from the OU1 area would be lower. However, selenium concentrations in the OU1 biota were not different than biota in reference areas. Therefore, the selenium levels in mice and voles in OU1 can be considered natural, and the concentration in an owl's diet would not be significantly lower in unimpacted areas. Thus, it appears that the risk of selenium poisoning is *not* greater in the OU1 area than it is in the natural areas of Rocky Flats.

E6.3.1.2 Radionuclides

The radionuclides plutonium, americium, and uranium were elevated in surface and subsurface soils at OU1 but were not elevated in other abiotic media (Table E4-2). Sample of vegetation, terrestrial arthropods, small mammals and fish from OU1 were analyzed for each of these radionuclides and concentrations of all three were slightly to significantly elevated (Table E6-4).

The radiation dose resulting from the measured tissue concentrations was calculated for each radionuclide and for the total radiation dose rate, using Eq. E5-5 (Table E6-14). The resulting dose from individual radionuclides was at least 10,000 times less than the critical dose rate of 0.1 rad/day. The total radiation dose from all three radionuclides was at least 1,000 times lower than the critical value (Table E6-14).

Tissue data were not available for species in higher trophic levels. Therefore, the total body burden was estimated for three predators after a three-year exposure to radionuclide concentrations measured in OU1 forage and prey species. Body burdens were calculated using Eq. E5-6 and biological half-life values obtained from the literature (Killough and McKay, 1976). The predicted body burdens for red-tailed hawks, coyotes, and great horned owls were 10,000 to 100,000 times less than the tissue concentrations required for the critical dose (Table E6-15).

The ingestion rates required to reach tissue concentrations that correspond to the critical dose rate were estimated in Table E5-5. Mean ingestion rates for key receptors were estimated using the Latin hypercube simulation procedure. The lognormal distribution was used to approximate the distribution of radionuclide concentrations in biota samples. The resulting mean ingestion rates were 1,000 to 1,000,000 times less than the critical ingestion rates (Tables E6-5 through E6-12).

Equation E5-6 was used to estimate the surface soil concentrations that could result in tissue concentrations above those required for the critical dose rate (Table E5-6). The effects criterion for plutonium in soils was estimated at 600,000 pCi/g (Table E5-6). This was three orders of magnitude over the mean surface soil concentration at OU1 (295 ± 1,776 pCi/g) and 54 times the site maximum (11,100 pCi/g). Similar relationships were observed for americium and uranium. The criteria for americium was estimated at 560,000 pCi/g while the mean (± sd) and maximum were 83 (± 461) and 2,650, respectively. The criterion for uranium was estimated at 1,800,000 while the mean (± sd) and maximum were 1.38 (± 0.72) and 4.69, respectively.

Although there was apparent radionuclide contamination at OU1, the levels in soils and biological tissues do not appear to threaten ecological receptors. The levels of external and internal exposures presented in this study agree with the previous study conducted at Rocky Flats by Little *et al.*, (1978) and other studies in the western United States (Hakonson, 1975; Bly and Whicker, 1978). The doses shown above are probably overestimates of the amount of radionuclides actually internalized and the amount from which effective dose is received. Other studies indicate that greater than 90 percent of the plutonium associated with small mammals either adheres to the pelt or is contained in the gastrointestinal tract (Hakonson, 1975). Because of the stopping power of intestinal contents, less than 1 percent of the available alpha particle dose is actually applied to the intestine wall (Killough and McKay, 1976). Less than one-half of gamma and beta emissions actually reach the intestine wall. Even the highest soil concentrations at OU1 do not appear to represent a threat to biota.

E6.3.1.3 Chlorinated Hydrocarbons and Toluene

The chlorinated solvents carbon tetrachloride, DCE, TCA, TCE, PCE, and toluene were detected at elevated levels in groundwater and soils at OU1. TCA and toluene were also detected in sediments. The initial toxicity screen indicated that site concentrations were not likely to be a threat to wildlife through ingestion of food, soil, or water at OU1 (see Section E4). However, each of these COCs was assessed for exposure of vegetation to contaminated groundwater, and the potential impact to air quality of burrows was assessed using site soil concentrations.

Hulzebos *et al.* (1993) investigated the effects of several organic compounds on plants growing in soil and in nutrient solutions. Data from nutrient solution tests were used to develop TRVs for exposure of vegetation roots to shallow groundwater (Table E5-3). OU1 areas of potential concern were identified using COC concentrations measured in groundwater samples collected from monitoring wells. Any well with a single sample that exceeded the TRV for exposure was included in the area of potential concern. The Thiessen polygon method was used to approximate the areas in which COC concentrations exceeded the TRV for one or more of the COCs.

Carbon tetrachloride, TCA, TCE, and PCE exceeded the TRV in at least one sample from three monitoring wells within IHSS 119.1 (Figure E6-11). The area defined by the above method covered about 0.04 ha, or about 0.04 percent of the OU1 ecological study area (approximately 100 ha).

Toluene exceeded the EEC for potential impacts to burrow air (Figure E6-12). No exceedence was identified for TCA or TCE (Table E5-7). Data on inhalation of DCE and PCE were insufficient to set a TRV. Areas in which toluene exceeded the effects criterion were identified using Thiessen polygons and covered approximately 2.15 ha. The highest toluene values were in areas outside of OU1 IHSSs (Figure E6-12). These sites did not overlap with the sites identified for exposure to contaminated groundwater (Figure E6-11). Thus, the source of toluene at OU1 does not appear to coincide with that of other VOCs encountered.

Based on the above data, it appears that chlorinated hydrocarbons represent little threat to vegetation in OU1. Less than one percent of the OU1 study area showed groundwater concentrations exceeding the TRV for exposure to vegetation. The monitoring wells on which the area was identified were constructed prior to Phase III activities. These data were also collected prior to Phase III activities, and concentrations of VOCs may have decreased due to chemical and biodegradation since the samples were collected.

Concentrations of toluene in subsurface soils may represent a threat to burrowing animals. Toluene irritates mucosal membranes of the eyes and respiratory tract at very low concentrations (EPA, 1993). Therefore, animals may avoid areas of contaminated soil when constructing burrows, thus reducing exposure. However, for purposes of this study no avoidance behavior is assumed and all areas exceeding the effects criterion are included in Figure E6-12.

Toluene and TCA were also detected in sediments of the SID. However, the concentrations did not exceed the SQC calculated from EPA interim SQC and organic carbon content (Table E5-1A). Sediment sampling sites were located in the SID, which is downgradient of the OU1 IHSSs and was built to intercept surface runoff and shallow groundwater flow from contaminated areas. Aquatic habitat quality of the SID is very poor, with only intermittent flows and a homogeneous substrate of silt and fine sand. Some aquatic invertebrates were collected from the sites within the SID, but fish were not present. Since toluene and TCA do not tend to bioaccumulate, contamination of sediments in the SID does not appear to represent a risk to upper level consumers.

E6.3.1.4 Polynuclear Aromatic Hydrocarbons

PAHs were detected in surface soils, subsurface soils, and sediment at OU1 (Table E4-2). PAHs were evaluated for exposure of burrowing mammals to soil, ingestion of plant or animal matter, and exposure of aquatic life to sediments.

Dermal exposure to PAHs in soils was evaluated by identifying sites for which samples exceeded the EEC for dermal exposure (Table E5-3). Exceedence of the criterion was noted at two borehole locations, BH 36591 and BH 36391, for three PAHs: benzo(a)pyrene, benzo(a)anthracene, and phenanthrene (Figure E6-13). For each of the PAHs, concentrations in subsurface soil samples at these locations were much higher than at other sampling sites. Thiessen polygons were constructed to represent the approximate areas of contamination (Figure E6-13). The areas around BH 36591 and BH 36391 cover approximately 0.6 ha and 0.33 ha, respectively. The total area is approximately 0.9 percent of the OU1 ecological study area.

Exposure due to ingestion of PAHs was evaluated by assuming that vegetation and small mammals at OU1 contain benzo(a)pyrene concentrations equal to the mean soil concentration. This conservative assumption was made because tissue levels of PAHs were not available from OU1 samples and no satisfactory values for PAH uptake by terrestrial organisms were found in the scientific literature. Benzo(a)pyrene is among the most toxic PAHs identified at OU1 and therefore was used as a benchmark for assessing the toxicity of ingested PAHs. Ingestion rates were estimated from simulation modeling as described for other COCs. A lognormal distribution about the mean concentration was assumed for vegetation and small mammals. For each of the receptors, the mean ingestion rate for benzo(a)pyrene was below the critical ingestion rate, 10 mg/kg bw/day (Tables E6-5 through E6-12). The probability of exceeding the critical value was essentially zero for all receptors (Figure E6-3 through E6-10).

The PAHs pyrene, phenanthrene, fluoranthene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in sediments in the SID. Site-specific SQC were calculated using EPA's interim criteria (Table E5-1B). None of the PAHs detected in sediments were found at concentrations that exceeded EPA's sediment criteria.

The reported mean concentration of phenanthrene was greater than the maximum detected concentration because of the way non-detect ("U"-qualified) data were treated. "U"-qualified data were used in the calculation of mean concentrations by dividing the detection limit or reported result by two (see Section E6.1.3 and Volume I, Phase III RFI/RI report, Section 4 and Appendix D). The detection limit for phenanthrene ranged from 410 to 1,100 μg/kg for sediment samples. Thus, the concentration represented by one-half of the lowest detection limit was higher than the SQC. This value was also higher than the maximum "J"-qualified value of 190 μg/kg. "J"-qualified data are values estimated below the detection limit. The end result is a sitewide mean that is influenced primarily by "U"-qualified data and may be higher than the actual site mean. This was not true for other PAHs detected in sediments (Table E5-1B).

As discussed above, the quality of aquatic habitat in the SID is of poor quality and supports a very limited aquatic community. Terrestrial animals, such as raccoons, could obtain food from the SID. However, the SID supports only isolated pools for most of the year and provides very little prey. Nearby Woman Creek is a much richer food resource and is more likely to attract predators.

E6.3.1.5 Polychlorinated Biphenyls

As described in Section E5, risk due to exposure to PCBs was assessed in three ways. First, an EEC for soil was calculated by estimating the soil PCB concentrations that would result in body burdens for predators equal to or less than the TRV. The critical tissue concentration, 0.6

mg/kg bw, was calculated from ingestion studies conducted with mink, the most sensitive vertebrate species tested. A bioaccumulation model was then used to estimate a protective soil concentration (Fordham and Reagan, 1991). The resulting EEC for soil was 0.69 mg/kg. Second, a TRV for rate of ingestion of PCBs was calculated based on studies with sensitive mammal and bird species. Third, the potential bioaccumulation of PCBs in tissues of three top predators was assessed using Eq. E5-6. The resulting tissue concentration was then compared to the MATC calculated for mink (0.6 mg/kg bw).

The EEC for soils was exceeded at three of 29 surficial soil sampling sites (Figure E6-14). Thiessen polygons were used to approximate the areal extent of the contaminated areas. Sites RA030 and RA031 are located in IHSS 119.2 (Figure E6-14). The individual concentrations of Aroclor 1248 and 1254 did not exceed the EEC, but the total PCB concentration (Aroclor 1248 and 1254 combined) did. The polygon drawn to represent the area covers 1.1 ha. Samples from site RA033 contained only Aroclor 1254, but the concentration (1.2 mg/kg) exceeded the EEC. The polygon drawn to represent this area covers 1.2 ha. The total area of the two sites is 2.3 ha or about 2 percent of the OU1 study area.

Mean ingestion rates were estimated using Latin hypercube sampling as described for other COCs. Since PCB concentrations were not measured in small mammals and vegetation, these concentrations were approximated. It was assumed that small mammal tissue concentrations were equal to soil concentrations and distributed lognormally. This assumption resulted in conservative estimates of PCB movement because the ratio of PCB concentrations in soil to that in small mammals is likely to be less than one. In investigations at a PCB-contaminated site, Boucher (1993) found the ratio to be 0.09.

The concentration of PCBs in vegetation was estimated by calculating the uptake of organic compounds by plants as in Baes *et al.* (1984):

Eq. E6-5

$$U = B * C_s$$

where:

U = uptake (μg/kg)

B = transfer coefficient (unitless)

C_s = concentration of contaminant in soil

The transfer coefficient, B, is calculated from the K_{ow} using the following equation (Travis and Arms, 1988):

Eq. E6-6

$$\log B = 1.588 - 0.578 \log K_{ow}$$

The concentration in vegetation was assumed to be distributed lognormally. The log K_{ow} of PCBs was taken to be 5.7 which is intermediate between the log K_{ow} of Aroclor 1242 and 1254 (EPA, 1979). The resulting transfer coefficient, B, is 0.013. The sitewide mean concentration of PCBs in soils was 0.16 μg/kg. The concentration in vegetation was estimated using Eq. E6-5 and was 0.0031 μg/kg. This value was used to estimate ingestion of PCBs for the deer mouse, voles, jumping mouse, and mule deer.

The distributions resulting from the simulation are presented in Figures E6-3 through E6-10. Estimated ingestion rates for key receptors are presented in Tables E6-5 through E6-12. Mean ingestion rates did not exceed the critical value for any receptor (Table E6-13), and the probability of exceeding the ingestion rate TRV did not exceed 1 percent for any receptor (Table E6-13).

The potential accumulation of PCBs in site predators was assessed using Eq. E5-6 and simulation modeling. The simulation assumed that coyotes, red-tailed hawks, and great horned owls consumed mice and voles from OU1. The ingestion rate was adjusted for the size of OU1 proportionate to the size of the receptors "home range" using the site use factor as above. It was also assumed that the BCF for transfer of PCBs from soil to mice was 0.09 (Boucher, 1993). The resulting mean whole body burdens for none of the species exceeded the target value of 0.6 mg/kg bw, and the maximum probability of exceeding the TRV was about 8 percent (Tables E6-5 through E6-12 and Table E6-16).

Aroclor 1254 was detected in sediments at sites SED037 and SED038 at concentrations of 86 and 84 μg/kg, respectively. Neither of these concentrations exceeded the site-specific SQC of 292.5 μg/kg (Table E5-1B). The interim SQC was developed by EPA to be protective of upper level consumers in aquatic foodwebs (EPA, 1988b). As discussed above, the SID is poor quality aquatic habitat and does not support a fish community. However, terrestrial receptors such as raccoons could be exposed if they take prey from temporary pools in the SID. This exposure would, however, be mitigated by the fact that available habitat and prey in the SID could supply only a fraction of a raccoon's diet.

E6.3.2 Summary of Exposure to Key Receptors

E6.3.2.1 Vegetation

The concentrations of COCs in soils at OU1 did not appear to represent a risk to vegetation (see Sections E4 and E5). Concentrations of VOCs in groundwater were potentially toxic to plants whose roots contact shallow groundwater. Two areas were identified in IHSS 119.1 that exceeded EECs for carbon tetrachloride, TCA, TCE, DCE, and PCE (Figure E6-11). The identified sections of IHSS 119.1 cover about 0.04 ha, about 0.04 percent of the OU1 ecological study area. The extent to which plant roots actually contact contaminated groundwater at OU1 cannot be quantified. However, the main root mass of most grass and herbaceous forb species (the dominant forms at OU1) occurs in the upper 15 to 30 centimeters (cm) of soil. Depth to groundwater in the area of IHSS 119.1 varies from approximately 2.0 to 4.5 meters (m) during late spring (see Table 3-10 of the OU1 Phase III RFI/RI Report). Water levels were approximately 1 m lower (deeper) during the driest times of year. Therefore, the majority of forb and grass root masses probably do not contact contaminated water. Deeper rooted plants such as shrubs and trees could contact groundwater in this area. However, at the time of the study only grasses and forbs were found growing in the IHSS 119.1 area.

Tree and shrub cover is extensive in the riparian corridor along the Woman Creek channel approximately 100 m south of IHSS 199.1. Since the site is located in the drainage of Woman Creek, it is possible that contaminants in OU1 groundwater could be transported to the riparian area. However, in 1992 a french drain was installed south of OU1 IHSSs as an interim measure to intercept contaminated groundwater for subsequent treatment. Monitoring wells downgradient of the French Drain have been predominately dry indicating the effectiveness of the action. Therefore, the risk of contaminated groundwater reaching roots of vegetation in the Woman Creek riparian corridor seems to be minimal.

E6.3.2.2 Small Mammals

Exposure of small mammals to COCs was assessed using a variety of methods (see Sections E4 and E5). Dermal and respiratory exposure to contaminants in subsurface soil was assessed because the young of many species are reared in burrows and spend long periods of time in contact with subsurface soils. The rate of incidental ingestion of COCs during consumption of vegetation or arthropods was estimated and compared to potentially toxic levels. Radiation dose rates were calculated using tissue concentrations measured in samples. Potential bioaccumulation of PCBs was also assessed although concentrations were not measured in tissue samples collected from the site.

The concentration of some PAHs exceeded the EEC for dermal exposure at two sample locations representing about 0.3 ha, or about 0.3 percent, of the OU1 ecological study area (Figure E6-13). Potential respiratory hazards were restricted to toluene concentrations in subsurface soils in an area representing about 2 percent of the OU1 area (Figure E6-13).

Tissue selenium concentrations in mice and voles from OU1 were not significantly higher that those from reference areas (Table E6-4). Body burdens of radionuclides were higher in samples from OU1 (Table E6-4), but the dose rates derived from those body burdens were far below rates considered significant (Table E6-14). Dose rates were calculated using the entire amount of radionuclides measured in whole-body assays. As noted in sections E5.2.2 and E6.3.1.2, this results in an overestimate of the radiation dose that the animal actually receives. Thus, it appears that radionuclide contamination at Rocky Flats poses no threat to small mammals.

Ingestion rates for COCs were assessed using concentrations of selenium and radionuclides measured in vegetation and terrestrial arthropods, and estimates of tissue content for other COCs. Ingestion rates of PAHs (as benzo(a)pyrene) and PCBs were assessed by assuming concentrations in food were equal to that of soil. This was a conservative assumption that probably overestimates ingestion rates. None of the COCs was ingested at rates approaching critical levels for deer mice (Table E6-5, Figure E6-3), voles (Table E6-6, Figure E6-4), or meadow jumping mice (Table E6-7, Figure E6-5). A summary of ingestion rate simulation results is presented in Figure E6-15.

Similar assumptions were adopted in assessing the soil concentrations that could lead to accumulation of radionuclides and PCBs to potentially toxic levels. Soil concentrations of radionuclides were below the critical levels. PCB concentrations in soils did exceed the critical soil concentrations at three sampling sites representing approximately 2 percent of the OU1 ecological study area (Figure E6-14).

E6.3.2.3 Mule Deer

Exposure of mule deer to selenium and radionuclides in food, water, and soil was assessed using the concentrations measured in samples collected from OU1. Ingestion rates for PCBs and PAHs were assessed using the same approach as described for small mammals. Results of simulation modeling indicate little chance that ingestion of site contaminants could lead to toxic effects (Figure E6-15). The low ingestion rate estimates result in part from the large home ranges that mule deer normally use and the relatively low levels of contamination at OU1. Mule deer could also be subject to dermal exposure to PAHs in surface soils if they were to lie down in contaminated areas. However, the areas of highest PAH concentrations are located in an area of high vehicle traffic and other human activity. The area is also highly disturbed and on a steep hillside. Thus, deer are unlikely to use these sites as bedding areas.

E6.3.2.4 Predators (Coyote, Red-tailed Hawk, Great Horned Owl, and Bald Eagle)

Exposure of predators to site contaminants in prey and, when appropriate, surface water. As noted previously, concentrations of selenium and radionuclides were measured in small mammal samples collected from the OU1 area. Biota samples were not analyzed for PAHs and PCBs because the presence of these chemicals was not anticipated prior to the investigation. In most cases conservative assumptions were made about the dietary fraction that was composed of deer mice and voles, the most common prey species available in the OU1 area. Deer mice and voles comprise varying proportions of the predators assessed (see Attachment E-1). However, for purposes of the exposure assessment it was assumed that all food obtained from the OU1 area contained the level of contaminants measured or estimated for small omnivorous rodents.

Exposure of coyotes to site contaminants was assessed for ingestion of prey (mice and voles) and surface water from OU1. Simulation of ingestion rates indicates little probability of exceeding TRVs for any of the COCs (Figure E6-15). The potential bioaccumulation of PCBs from site prey was assessed using estimated uptake of PCBs by small mammals (Boucher, 1993)(Table E6-17). These calculations suggest that there is less than a 1-percent chance that bioaccumulation of PCBs would exceed the MATC of 0.6 mg/kg bw (Table E6-17, Figure E6-7).

Exposure to contaminants in soils may also be relevant to coyotes since they often rear their young in dens. However, most of the OU1 area is within 100 m of heavily used industrial portions of RFP and therefore probably not suitable for den sites. As discussed for small mammals, PAH levels in soils around IHSSs 104 and 130 exceeded the EEC for dermal exposure (Figure E6-13). Toluene concentrations in soils also exceeded EEC for air in burrows (Figure E6-12).

Similar calculations for the red-tailed hawk, great horned owl, and bald eagle yielded similar results. Latin hypercube simulation of ingestion rates for COCs indicates that the probability of exceeding critical values is low or negligible for most COCs (Figure E6-15). The highest probability was associated with ingestion of selenium by great horned owls (13 percent). However, selenium concentrations in animals and vegetation sampled from OU1 were not higher than in samples from the reference area (Table E6-4). Therefore, ingestion of selenium by owls at OU1 would not exceed that in unimpacted areas. Exposure to the bald eagle was assessed assuming ingestion of mice and voles, which are not normally a large component of their diet. Bald eagles typically consume larger mammals (such as rabbits and prairie dogs), waterfowl, and fish. Tissue contaminant concentrations from mice and voles were assumed in this calculation because tissue data were not available for these species. This also was considered to be a conservative approach, because large prey would occupy larger home ranges than mice or voles and thus be less exposed to site contaminants. The exception would be prairie dogs, which are sedentary but do not occur in or near OU1. Tissue data for fish were not used because Pond C-2, the only aquatic environment near OU1 that is large enough for a foraging bald eagle, does not contain fish of adequate size.

Table E6-1

Key Receptor Species for OU1 Environmental Evaluation

Common Name	Scientific Name
Vegetation	in general
Soil Invertebrates	in general
Deer Mouse	*Peromyscus maniculatus*
Meadow Vole	*Microtus pennsylvanicus*
Prairie Vole	*Microtus ochrogaster*
Mule Deer	*Odocoileus hemionus*
Coyote	*Canis latrans*
Red-tailed Hawk	*Buteo jamaicensis*
Great Horned Owl	*Bubo virginianus*
Species of special concern	
Bald Eagle	*Haliaeetus leucocephalus*
Preble's Jumping Mouse	*Zapus hudsonius preblei*

Table E6-2

Exposure Routes and Exposure Points Analyzed for Key Receptor Species: OU1 Environmental Evaluation

Key Receptor	Exposure Route	Exposure Points
Vegetation	direct contact with soil	soils within OU1 IHSSs soils outside OU1 IHSSs
Soil Invertebrates	direct contact with soil	soils within OU1 IHSSs soils outside OU1 IHSSs
Deer Mouse	inhalation in burrow dermal contact ingestion of vegetation	soils within OU1 soils within OU1 vegetation within OU1
Meadow Vole/Prairie Vole	inhalation in burrow ingestion of vegetation	soils within OU1 vegetation within OU1
Preble's Jumping Mouse	direct contact with soil ingestion of vegetation and terrestrial arthropods	soils within OU1 vegetation within OU1 terrestrial arthropods within OU1
Mule Deer	ingestion of soil ingestion of vegetation ingestion of surface water	soils within OU1 vegetation within OU1 surface water in Woman Cr. & SID
Coyote	inhalation in burrow ingestion of prey (small mammals) ingestion of surface water	soils within OU1 mice and voles in OU1 surface water in Woman Cr. & SID
Red-tailed Hawk	ingestion of prey	mice and voles in OU1
Great Horned Owl	ingestion of prey	mice and voles in OU1
Largemouth Bass	ingestion of prey direct exposure to surface water	fish and crayfish in Pond C-1 surface water in Pond C-1

Table E6-3

Exposure Point Concentrations for OU1 Environmental Evaluation[a,b]

COC	Soil[c] (mg/kg)	Burrow Air (mg/cu. m)	Surface Water (mg/L)		Sediment (mg/kg)	Ground-water (mg/L)	Vegetation (mg/kg)	Small Mammals (mg/kg)	Terrestrial Arthropods (mg/kg)
Selenium	0.25	NA	1.3 1.4	UF F	0.56	210	0.73	3.2	3.4
Plutonium-239,240 (pCi/g or pCi/L)	2.4	NA	0.0071 ND	UF F	1.3	0.012	0.015	0.034	0.015
Amercium-241 (pCi/g or pCi/L)	0.41	NA	0.021 0.048	UF F	0.027	0.010	0.0065	0.0060	0.0050
Uranium (total) (pCi/g or pCi/L)	2.4	NA	5.8 3.9	UF F	0.94	14	0.12	0.13	0.042
Carbon Tetrachloride	0.0031	6	NA		NA	0.081	NA	NA	NA
1,1,1-Trichloroethane	0.0030	7.7	0.0025		0.0038	0.36	NA	NA	NA
Trichloroethene	0.0043	4.1	0.0025		0.0037	0.37	NA	NA	NA
Tetrachloroethene	0.0034	5.9	0.0025		0.0037	0.10	NA	NA	NA
1,1-Dichloroethene	0.0031	9.0	0.0025		0.0037	0.28	NA	NA	NA
Toluene	0.11	61	0.0025		0.0040	0.0047	NA	NA	NA
PAHs (Benzo(a)pyrene)	0.26	NA	ND		0.26	0.0050	0.26	0.26[e]	NA
PCBs (Aroclor-1254 & -1248)	0.16[d]	NA	ND		0.21	ND	0.0031	0.16[e]	NA

[a]OU1 IHSS and non-IHSS data were combined for surface and subsurface soil values and Study Area data was used for tissue values

[b]Units indicated in column heading unless otherwise noted

[c]Values for metals, radionuclides, PAHs, and PCBs are from surface soil data and values for volatiles are from subsurface soil data

[d]Method detection limit

[e]Assumes that concentration in small mammals is equal to that in soil

UF = Data for unfiltered samples; used for exposure due to ingestion

F = Data for filtered samples; used for exposure due to direct contact

ND = Not detected

NA = Not analyzed

Table E6-4

Tissue Concentrations of COCs from Reference and Study Area Biota Samples

Analyte	OU1 Study Area Mean ± std. dev.	Reference Area Mean ± std. dev.	Wilcoxon Two-Sample Comparison[a]
Vegetation			
Selenium (mg/kg)	0.73 ± 0.99	0.42 ± 0.037	ns
Plutonium (pCi/g)	0.015 ± 0.028	6.0E-04 ± 5.0E-04	•
Americium (pCi/g)	0.0065 ± 0.017	7.0E-04 ± 9.0E-04	ns
Uranium (pCi/g)	0.12 ± 0.30	0.047 ± 0.0075	ns
Terrestrial Arthropods			
Selenium (mg/kg)	3.4 ± 1.2	3.2 ± 0.44	ns
Plutonium (pCi/g)	0.015 ± 0.015	0.0057 ± 0.0081	ns
Americium (pCi/g)	0.0050 ± 0.0090	7.0E-04 ± 6.0E-04	ns
Uranium (pCi/g)	0.042		
Small Mammals			
Selenium (mg/kg)	3.2 ± 1.8	2.6 ± 0.48	ns
Plutonium (pCi/g)	0.034 ± 0.12	0.0012 ± 0.0013	•
Americium (pCi/g)	0.0060 ± 0.021	2.0E-04 ± 7.0E-04	ns
Uranium (pCi/g)	0.13 ± 0.065	0.11 ± 0.027	•
Fish			
Selenium (mg/kg)	3.7 ± 3.8	9.1 ± 8.8	ns
Plutonium (pCi/g)	0.011 ± 0.029	0.0031 ± 0.0063	ns
Americium (pCi/g)	0.0016 ± 0.0038	3.0E-04 ± 5.9E-04	ns
Uranium (pCi/g)	0.12 ± 0.13	0.21 ± 0.25	ns

[a]Statistical comparisons were performed using the Wilcoxon two-sample test (Sokal and Rohlf 1969)

• Study area and Reference areas are significantly different ($p<0.05$)

ns = Study area and Reference areas not significantly different ($p<0.05$)

Table E6-5

Exposure Estimations for Deer Mice[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in food (C_f)[b] mean	sd	Assimilation *a* unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[c] mean	sd
Selenium	0.0032	0.73	0.99	1	1	0.019	0.12	0.15
Plutonium-239,-240	0.0032	0.015	0.028	0.001	1	0.019	2.6E-06	5.0E-06
Americium-241	0.0032	0.0065	0.017	0.001	1	0.019	1.1E-06	3.2Γ-06
Uranium (total)	0.0032	0.12	0.30	0.001	1	0.019	2.0E-05	4.2E-05
Benzo(a)pyrene	0.0032	0.26	0.14	1	1	0.019	0.044	0.024
Total PCBs	0.0032	0.0031	0.0027	1	1	0.019	0.00052	0.00044

[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Mean of 500 iterations.

Table E6-6

Exposure Estimations for Meadow Voles and Prairie Voles[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in food (C_f)[b]		Assimilation *a* unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[c]	
		mean	sd				mean	sd
Selenium	0.0057	0.73	0.99	1	1	0.051	0.082	0.11
Plutonium-239,-240	0.0057	0.015	0.028	0.001	1	0.051	1.7E-06	2.8E-06
Americium-241	0.0057	0.0065	0.017	0.001	1	0.051	7.2E-07	1.6E-06
Uranium (total)	0.0057	0.12	0.30	0.001	1	0.051	1.4E-05	3.6E-05
Benzo(a)pyrene	0.0057	0.26	0.14	1	1	0.051	0.029	0.015
Total PCBs	0.0057	0.0031	0.0027	1	1	0.051	0.00035	0.00030

[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Mean of 500 iterations.

Table E6-7

Exposure Estimations for Meadow Jumping Mice[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in TA (C_f)[b]		Concentration in vegetation(C_f)[b]		Assimilation a unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[c]	
		mean	sd	mean	sd				mean	sd
Selenium	0.0033	3.4	1.2	0.73	0.99	1	1	0.019	0.33	0.10
Plutonium-239,-240	0.0033	0.015	0.015	0.015	0.028	0.001	1	0.019	2.7E-06	2.2E-06
Americium-241	0.0033	0.0050	0.0090	0.0065	0.017	0.001	1	0.019	1.3E-06	1.3E-06
Uranium (total)	0.0033	0.042	d	0.12	0.30	0.001	1	0.019	1.4E-05	2.1E-05
Benzo(a)pyrene	0.0033	0.26	0.14	0.26	0.14	0.9	1	0.019	0.041	0.016
Total PCBs	0.0033	0.0031	0.0027	0.0031	0.0027	0.9	1	0.019	0.00048	0.00029

[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Mean of 500 iterations.

[d]Only one sample available.

TA = terrestrial arthropods

Table E6-9

Exposure Estimations for Coyotes[a]

COC	Food ingestion rate (FIR) kg/day[b]	Concentration in food(C_f)[c]		Assimilation a unitless	Water ingestion rate (WIR) L/day[b]	Concentration in water (C_w)[d]		Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[e]	
		mean	sd			mean	sd			mean	sd
Selenium	0.81	3.2	1.8	1	0.89	1.3	0.36	0.1	12	0.033	0.014
Plutonium-239,-240	0.81	0.034	0.12	0.001	0.89	0.0071	0.0052	0.1	12	5.5E-05	3.9E-05
Americium-241	0.81	0.0060	0.021	0.001	0.89	0.021	0.038	0.1	12	1.6E-04	2.6E-04
Uranium (total)	0.81	0.13	0.065	0.001	0.89	5.8	7.5	0.1	12	0.045	0.054
Benzo(a)pyrene	0.81	0.26	0.14	1	0.89	ND	---	0.1	12	0.0018	9.8E-04
Total PCBs	0.81	0.16	0.17	1	0.89	ND	---	0.1	12	0.0011	0.0011

[a]Exposure estimations calculated using Eq. E6-1.

[b]Value for lactating females

[c]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclide concentrations are expressed in nCi/kg.

[d]Metal, PAH, and PCB concentrations are expressed in mg/L, and radionuclide concentrations are expressed in nCi/L.

[e]Mean of 500 iterations.

ND = not detected

Table E6-10

Exposure Estimations for Red-tailed Hawk

COC	Food ingestion rate (FIR) kg/day	Concentration in food (C_f)[a]		Assimilation *a* unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[b]	
		mean	sd				mean	sd
Selenium	0.14	3.2	1.8	1	0.67	1.1	0.26	0.15
Plutonium-239,-240	0.14	0.034	0.12	0.001	0.67	1.1	3.0E-06	1.2E-05
Americium-241	0.14	0.0060	0.021	0.001	0.67	1.1	4.7E-07	1.2E-06
Uranium (total)	0.14	0.13	0.065	0.001	0.67	1.1	1.0E-05	5.2E-06
Benzo(a)pyrene	0.14	0.26	0.14	1	0.67	1.1	0.021	0.011
Total PCBs	0.14	0.16	0.17	1	0.67	1.1	0.013	0.013

[a]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclide concentrations are expressed in nCi/kg.

[b]Mean of 500 iterations.

Table E6-11

Exposure Estimations for Great Horned Owl[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in food (C_f)[b]		Assimilation a unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[c]	
		mean	sd				mean	sd
Selenium	0.16	3.2	1.8	1	1	1.5	0.34	0.19
Plutonium-239,-240	0.16	0.034	0.12	0.001	1	1.5	3.6E-06	1.0E-05
Americium-241	0.16	0.0060	0.021	0.001	1	1.5	6.4E-07	1.9E-06
Uranium (total)	0.16	0.13	0.065	0.001	1	1.5	1.4E-05	6.9E-06
Benzo(a)pyrene	0.16	0.26	0.14	1	1	1.5	0.028	0.015
Total PCBs	0.16	0.16	0.17	1	1	1.5	0.017	0.018

[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Mean of 500 iterations.

Table E6-12

Exposure Estimations for Bald Eagle[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in food (C_f)[b] mean	sd	Assimilation *a* unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day)[c] mean	sd
Selenium	0.5	3.2	1.8	1	0.1	4.7	0.034	0.019
Plutonium-239,-240	0.5	0.034	0.12	0.001	0.1	4.7	3.6E-07	1.1E-06
Americium-241	0.5	0.0060	0.021	0.001	0.1	4.7	6.5E-08	2.1E-07
Uranium (total)	0.5	0.13	0.065	0.001	0.1	4.7	1.4E-06	7.0E-07
Benzo(a)pyrene	0.5	0.26	0.14	1	0.1	4.7	0.0028	0.0015
Total PCBs	0.5	0.16	0.17	1	0.1	4.7	0.0017	0.0018

[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Mean of 500 iterations.

Table E6-13

Estimated Daily Ingestion Rate and Target Values for Selenium and PCBs

Species	Dietary Content TRV (mg/kg)	Estimated Ingestion Rate[a] (mg/kg-day) mean	±	std dev	Target Ingestion Rate (TIR) (mg/kg bw/day)	Probability of Exceeding TIR
Selenium						
Deer Mouse	5	0.12	±	0.15	0.84	0.81%
Meadow/Prairie Vole	5	0.08	±	0.11	0.56	0.74%
Meadow Jumping Mouse	5	0.33	±	0.1	0.87	0.31%
Mule Deer	5	0.008	±	0.011	0.11	0.06%
Coyote	5	0.022	±	0.012	0.35	0%
Red-tailed Hawk	5	0.26	±	0.15	0.61	2.68%
Great Horned Owl	5	0.34	±	0.19	0.54	12.97%
Bald Eagle	5	0.03	±	0.02	0.53	0%
PCBs						
Deer Mouse	0.18	5.00E-04	±	5.00E-04	0.027	0%
Meadow/Prairie Vole	0.18	0.0003	±	0.0003	0.018	0%
Meadow Jumping Mouse	0.18	4.80E-04	±	2.90E-04	0.028	0%
Mule Deer	0.18	4.90E-05	±	3.20E-05	0.0036	0%
Coyote	0.18	0.0011	±	0.0011	0.011	0%
Red-tailed Hawk	1.4	0.013	±	0.013	0.15	0%
Great Horned Owl	1.4	0.017	±	0.018	0.14	0.21%
Bald Eagle	1.4	0.002	±	0.002	0.13	0%

[a]Mean derived from latin-hypercube simulation based on tissue and soil data from OU1

Table E6-14

Calculation of Internal Radiation Dose Rates for Terrestrial Receptors[a]

Receptor	Radionuclide	OU1 Tissue Conc. (pCi/g)	dis/min-g	Effective Absorbed Dose (MeV/dis)	Whole Body Dose (rad/day)	Body Burden Required for Critical Dose Rate (=0.1 rad/day)
Vegetation	Pu-239,-240	0.015	2.22	53	4.07E-05	36.8 pCi/g
	Am-241	0.0065	2.22	57	1.90E-05	34.3
	Uranium (total)	0.012	2.22	49	3.01E-05	40
				Total	8.97E-05	
Terrestrial Arthropods	Pu-239,-240	0.015	2.22	53	4.07E-05	36.8
	Am-241	0.005	2.22	57	1.46E-05	34.3
	Uranium (total)	0.042	2.22	49	1.05E-04	40
				Total	1.61E-04	
Small Mammals	Pu-239,-240	0.034	2.22	53	9.22E-05	36.8
	Am-241	0.006	2.22	57	1.75E-05	34.3
	Uranium (total)	0.13	2.22	49	3.26E-04	40
				Total	4.35E-04	
Fish	Pu-239,-240	0.011	2.22	53	2.98E-05	36.8
	Am-241	0.0016	2.22	57	4.66E-06	34.3
	Uranium (total)	0.12	2.22	49	3.01E-04	40
				Total	3.35E-04	

[a]Dose rates calculated using Eq. E5-5

Table E6-15

Estimated Accumulation of Radionuclides in Three Predators After a Three-Year Exposure

Species	C_f[a] (mg/kg)	FIR (kg/day)	Assimilation a (unitless)	Mass (kg)	Biological Half-life[b] (days)	k_e (1/day)	t (days)	Body Burden (pCi/g)	Body Burden Required for Critical Dose Rate (=0.1 rad/day)
Plutonium									
Red-tailed Hawk	3.40E-02	0.14	0.001	1.1	65,000	1.07E-05	1,095	4.71E-03	36.8 pCi/g
Great Horned Owl	3.40E-02	0.16	0.001	1.5	65,000	1.07E-05	1,095	3.95E-03	
Coyote	3.40E-02	0.81	0.001	12	65,000	1.07E-05	1,095	2.50E-03	
Americium									
Red-tailed Hawk	6.00E-03	0.14	0.001	1.1	20,000	3.47E-05	1,095	8.21E-04	34.3
Great Horned Owl	6.00E-03	0.16	0.001	1.5	20,000	3.47E-05	1,095	6.88E-04	
Coyote	6.00E-03	0.81	0.001	12	20,000	3.47E-05	1,095	4.35E-04	
Uranium									
Red-tailed Hawk	1.30E-01	0.14	0.001	1.1	100	0.00693	1,095	2.39E-03	40
Great Horned Owl	1.30E-01	0.16	0.001	1.5	100	0.0069	1,095	2.01E-03	
Coyote	1.30E-01	0.81	0.001	12	100	0.0069	1,095	1.27E-03	

[a]Concentration in small mammals trapped at OU1

[b]Values from Killough and McKay (1976)

Table E6-16

Estimated Concentrations of Volatile Organic COCs in Air of a Hypothetical Animal Burrow

COC	Burrow Air Concentration at Mean Soil Conc. (mg/cu. m)	Burrow Air Concentration at Maximum Soil Conc. (mg/cu. m)
Carbon Tetrachloride	6	38
Toluene (C6H5CH3)	61	1,130
Trichloroethene	4.1	135
1,1,1-Trichloroethane	7.7	13
Tetrachloroethene	5.9	82
1,1-Dichloroethene	9	35

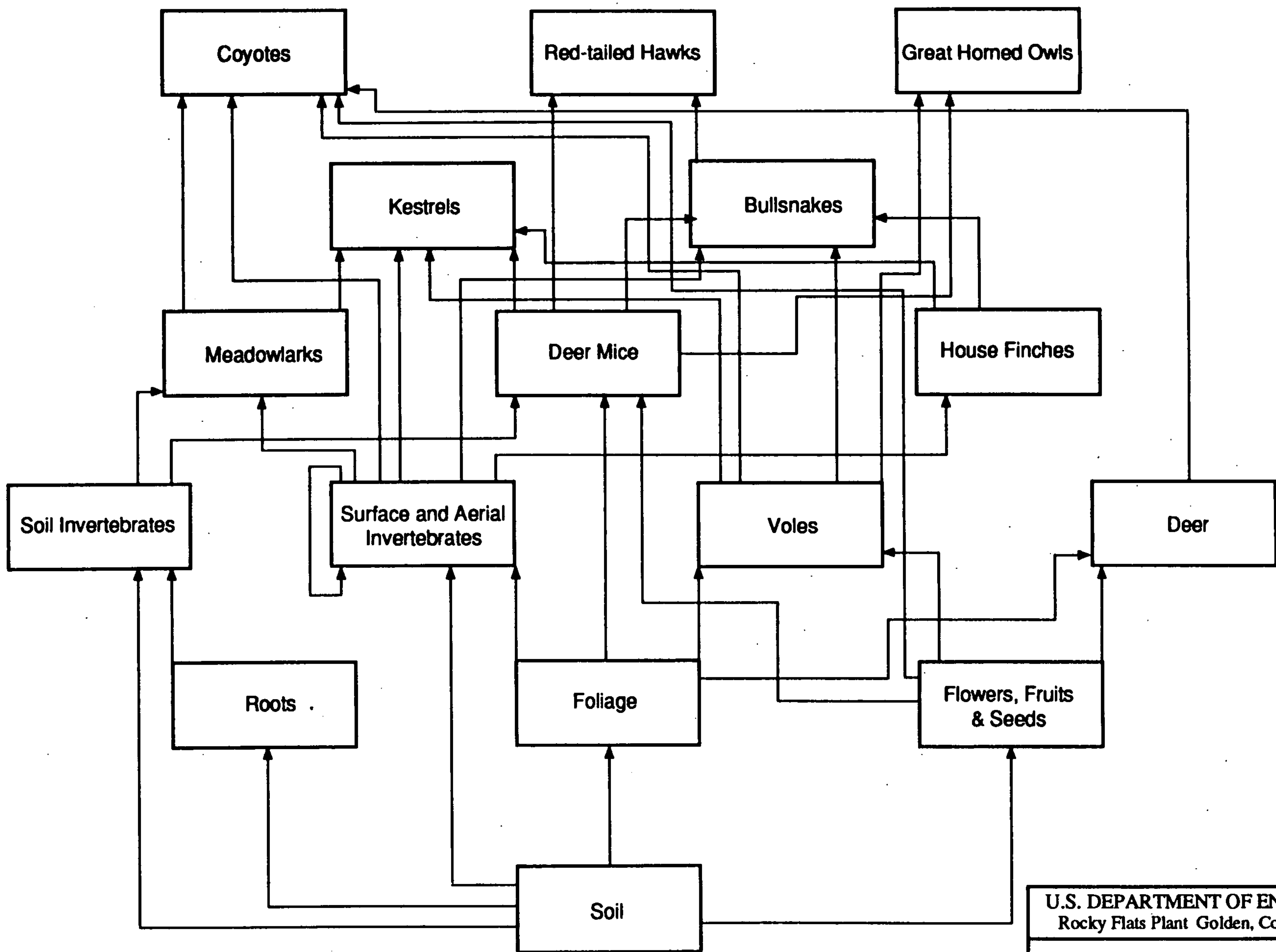
Table E6-17

Results of Simulation of PCB Bioaccumulation in Three Predators at OU1

Species	Soil Conc. (mg/kg)	Predicted C_f[a] (mg/kg)	FIR (kg/day)	Assimilation a (unitless)	Site Use Factor (unitless)	Mass (kg)	Biological Half-life (days)	k_e (per day)	t (days)	Predicted Body Burden[b] (mean +/- std dev) (mg/kg)	Probability of Exceeding MATC (= 0.6 mg/kg bw)
Red-tailed Hawk	0.16	0.0144	0.14	0.9	0.67	1.1	125	0.0055	365	0.17 ± 0.18	3.4%
Great Horned Owl	0.16	0.0144	0.16	0.9	1	1.5	125	0.0055	365	0.22 ± 0.24	5.7%
Coyote	0.16	0.0144	0.81	0.9	0.1	12	125	0.0055	365	0.014 ± 0.015	<<1%

[a]Predicted concentration assumes BCF = 0.09 for transfer of PCBs from soils to deer mice (Boucher, 1993)

[b]Mean and probability of exceeding TRV derived from Latin-hypercube simulation based on soil data from OU1



1 All trophic groups may be directly exposed to contaminants in soil and/or surface water (see text).

M\ES\FOODWEB E6-2.MDW\8-17

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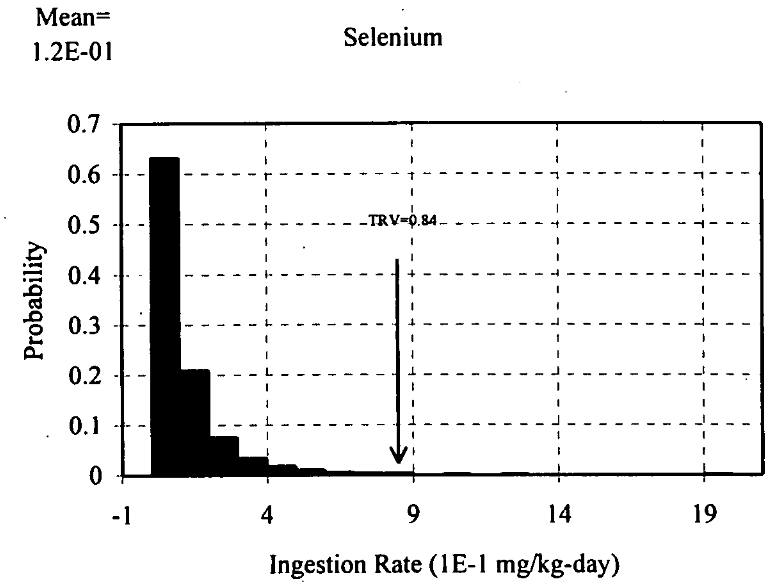
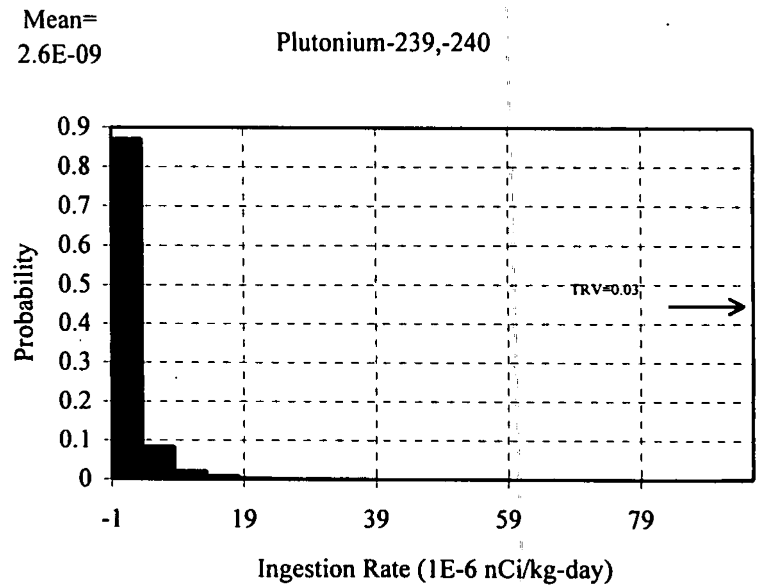
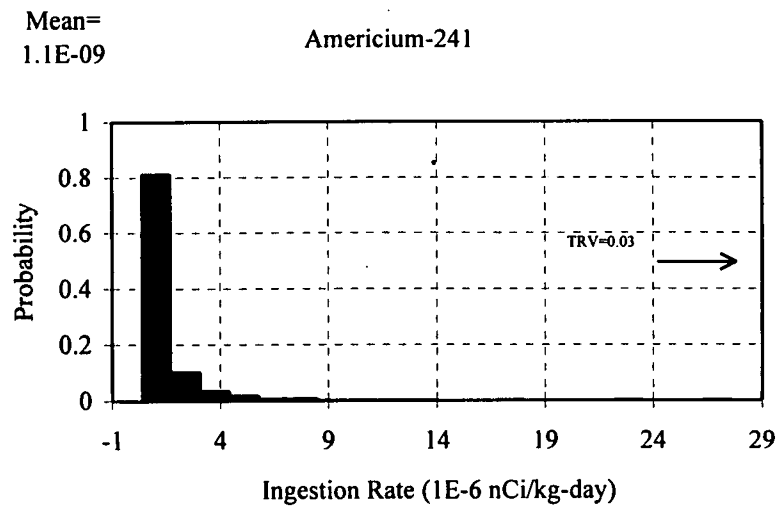
Terrestrial Food Web, OU1

Figure E6-2







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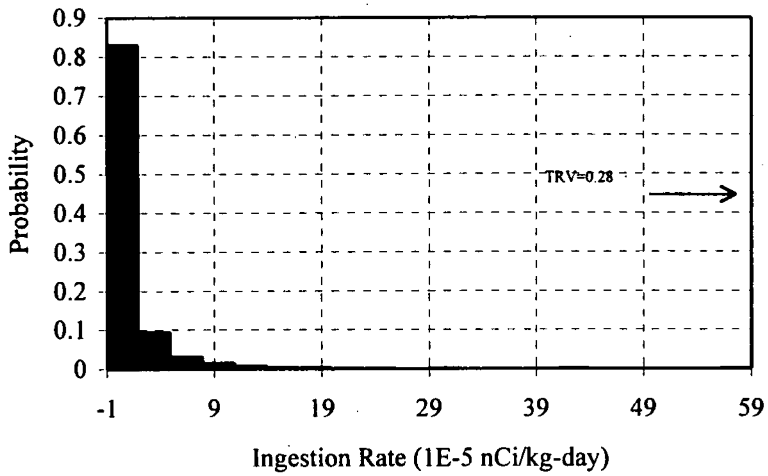
Results of Ingestion Rate Simulation Modeling
for Deer Mice
Figure E6-3A

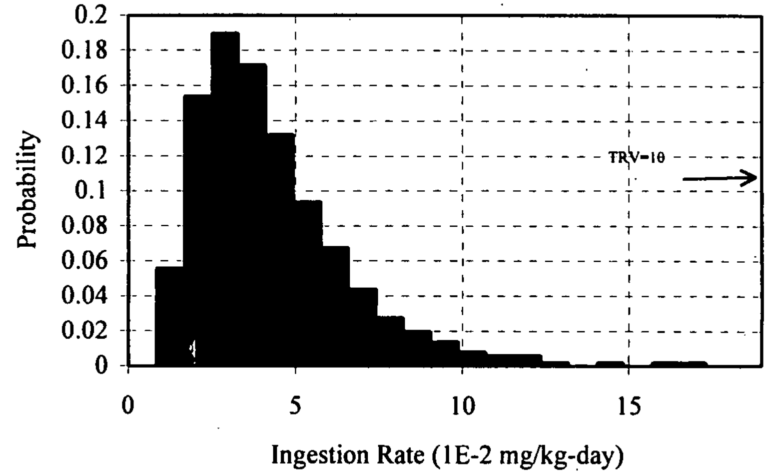
Mean=
2.0E-08

Uranium (total)



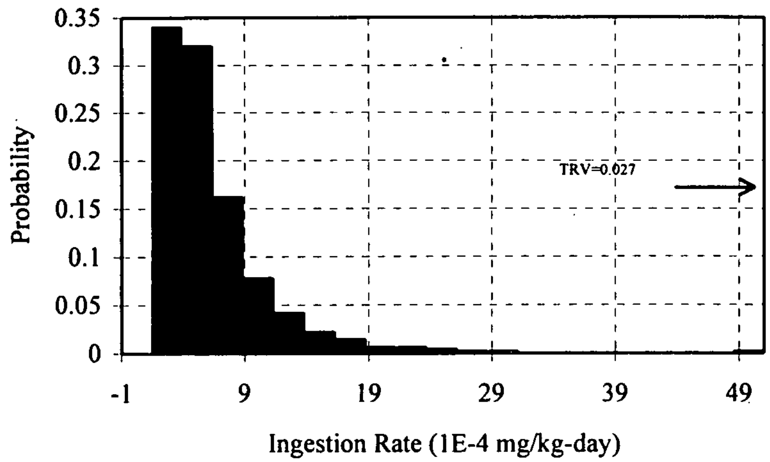
Mean=
4.4E-02

Benzo(a)pyrene



Mean=
5.2E-04

Total PCBs



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881 HILLSIDE AREA
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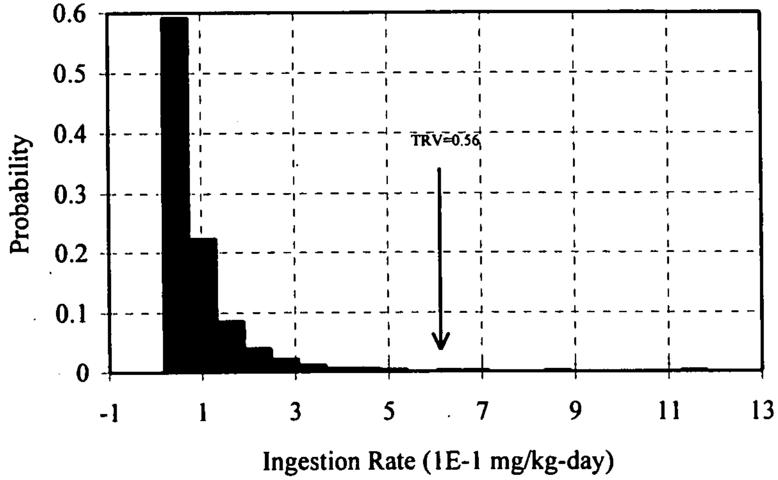
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Deer Mice
Figure E6-3B

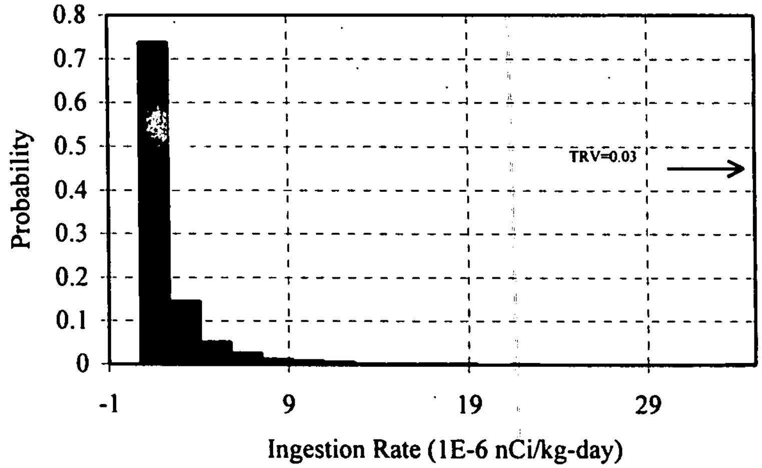
Mean=
8.2E-02

Selenium



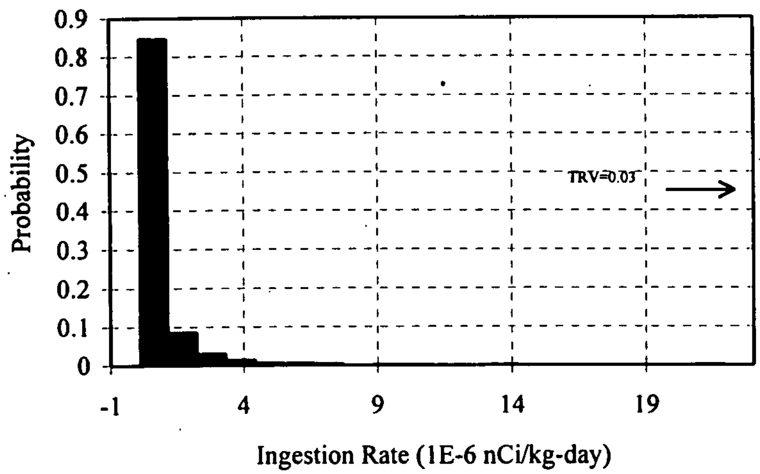
Mean=
1.7E-09

Plutonium-239,-240



Mean=
7.2E-10

Americium-241



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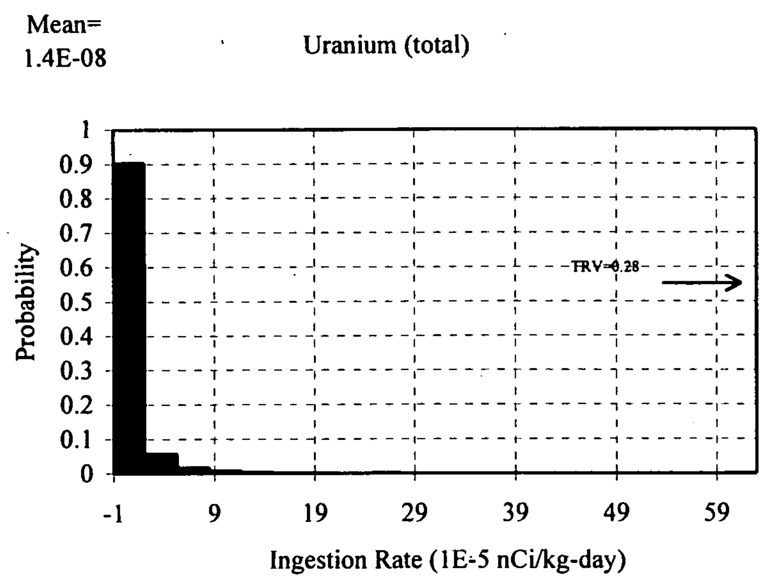
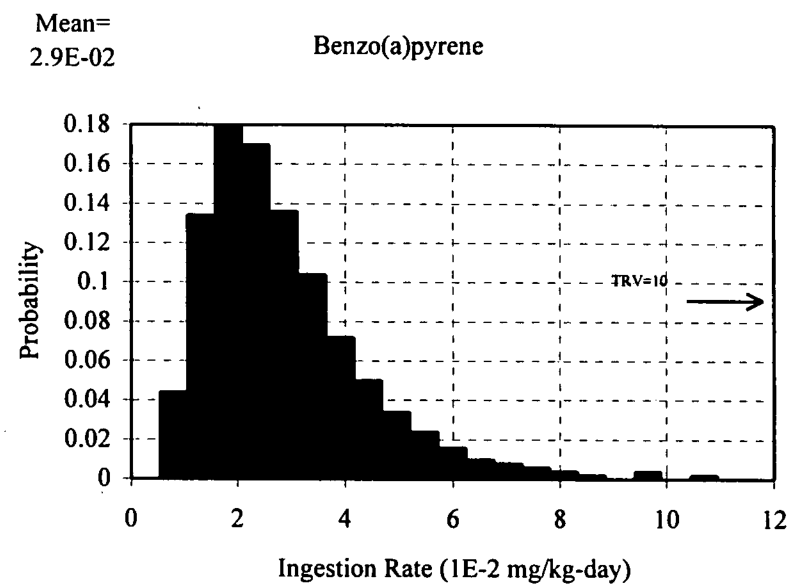
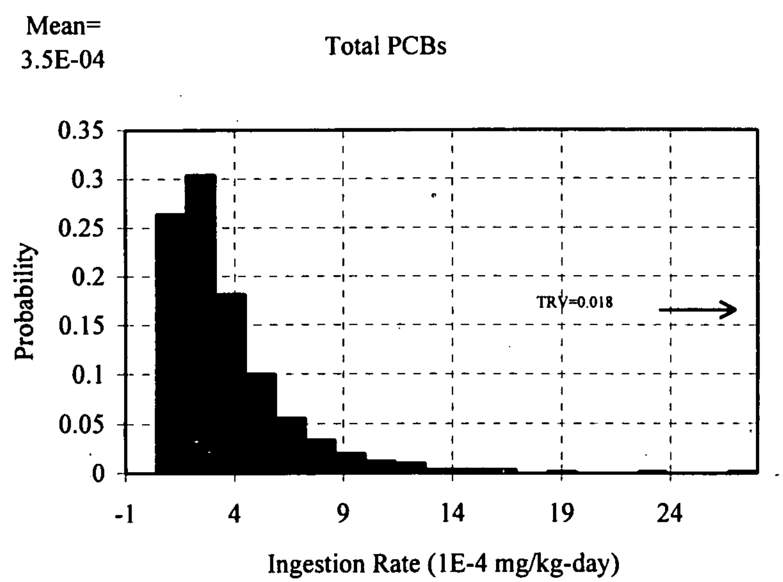
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Meadow and Prairie Voles
Figure E6-4A







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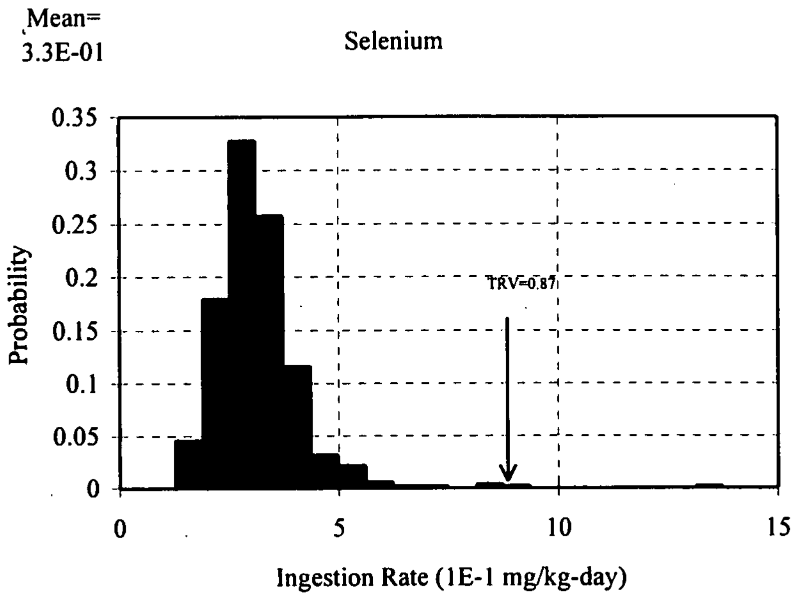
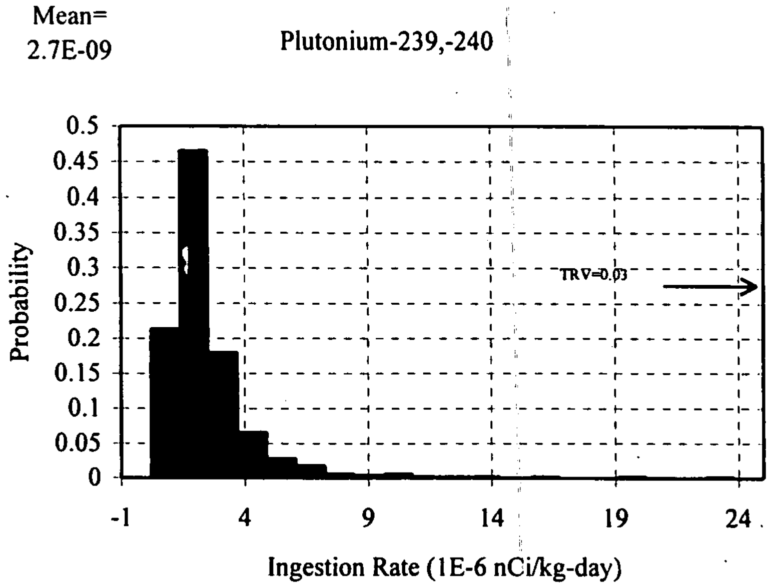
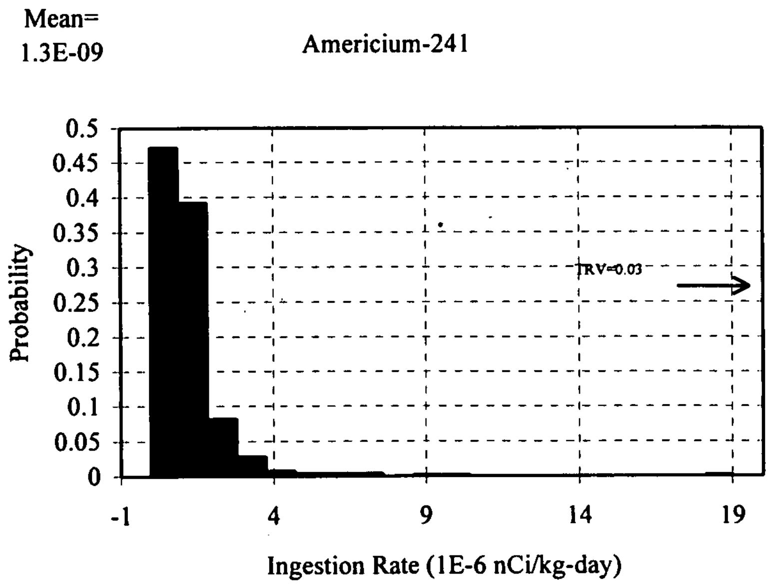
Results of Ingestion Rate Simulation Modeling for Meadow and Prairie Voles
Figure E6-4B







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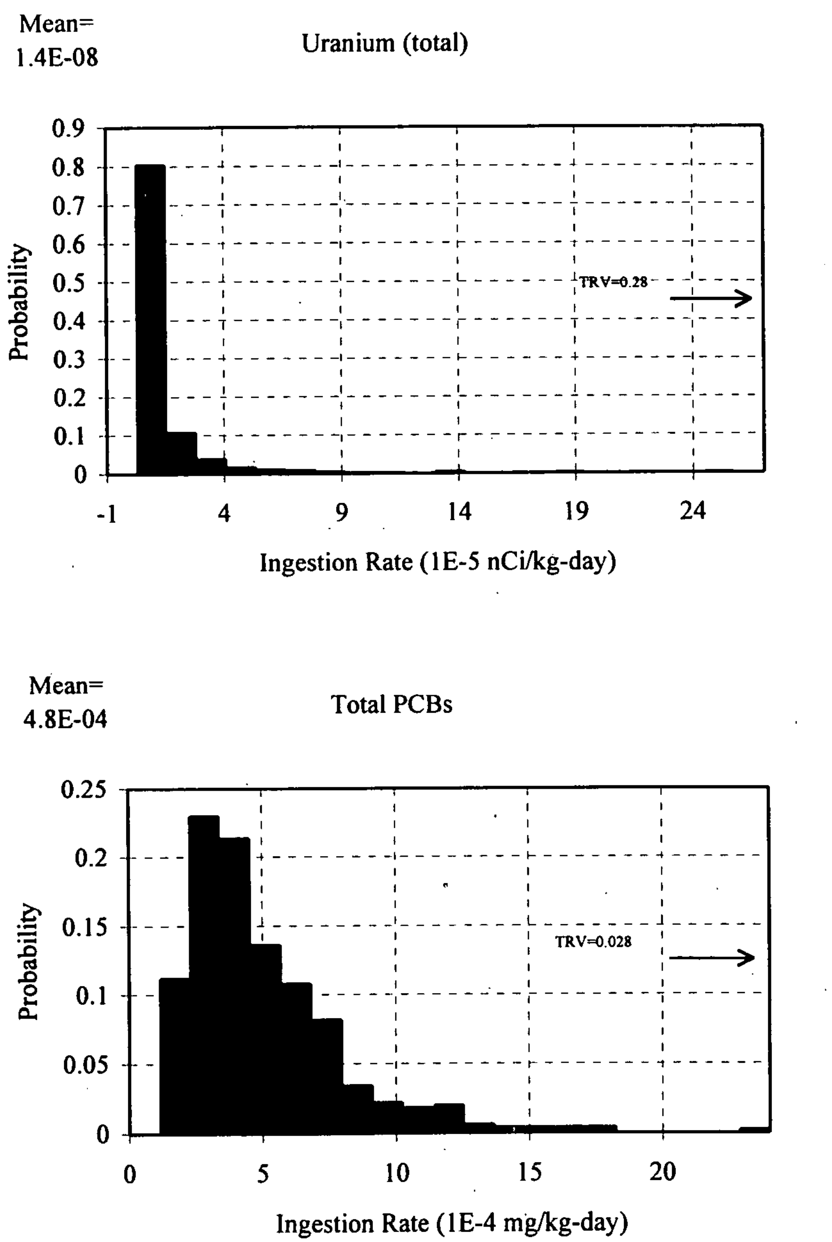
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Meadow Jumping Mouse
Figure E6-5A

FE6-5.XLS



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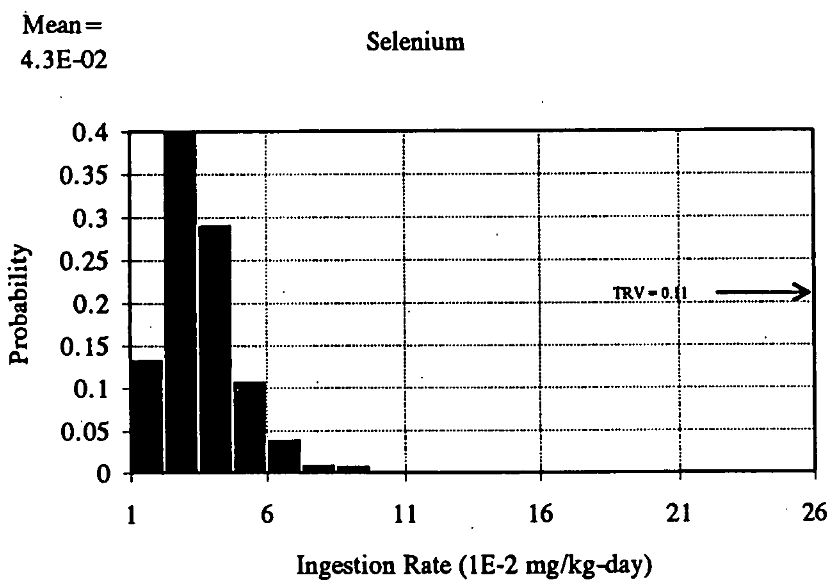
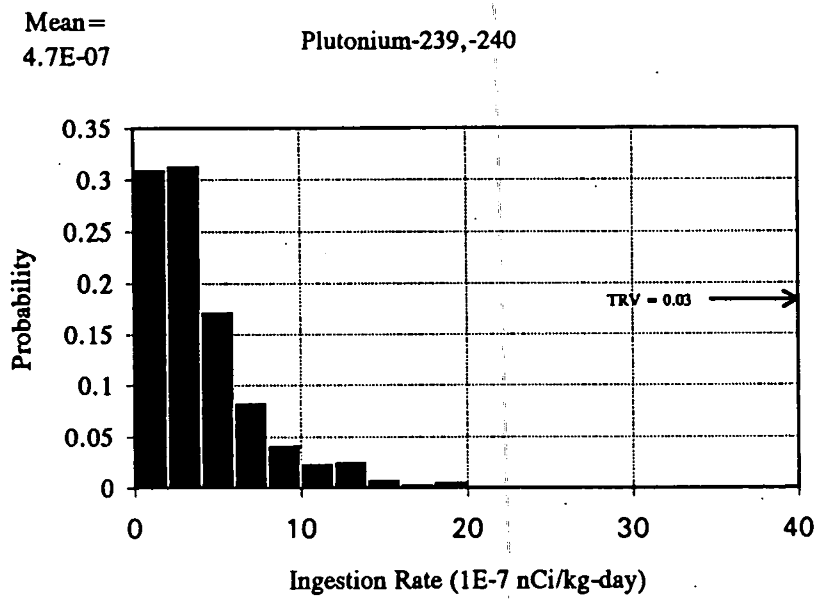
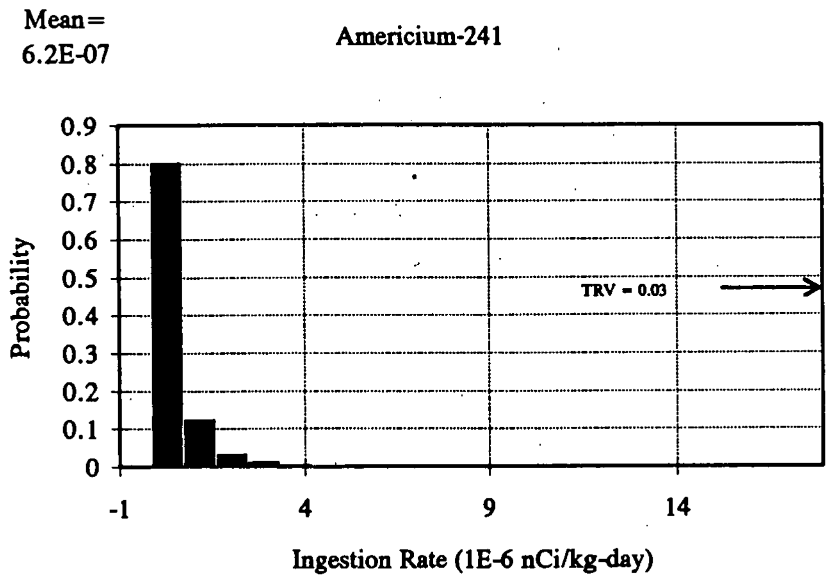
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Meadow Jumping Mouse
Figure E6-5B

FE6-5.XLS 5/18/94







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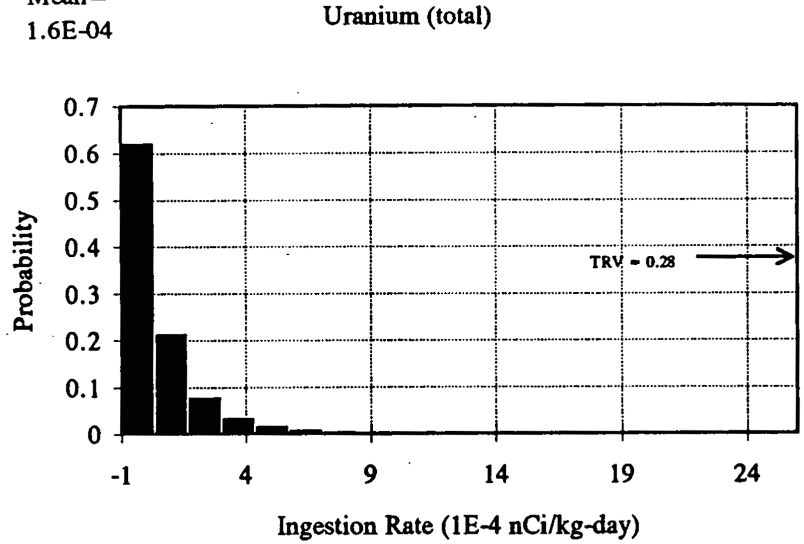
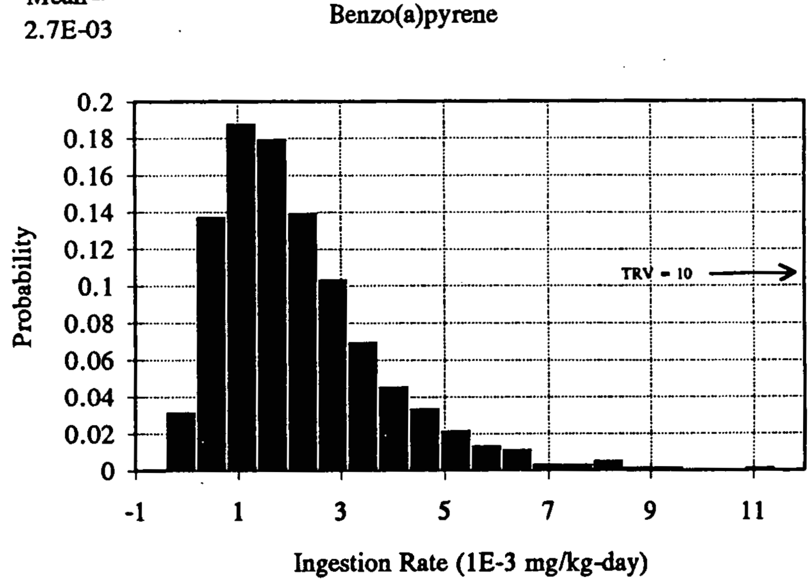
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Mule Deer
Figure E6-6A

FE6-6.XL

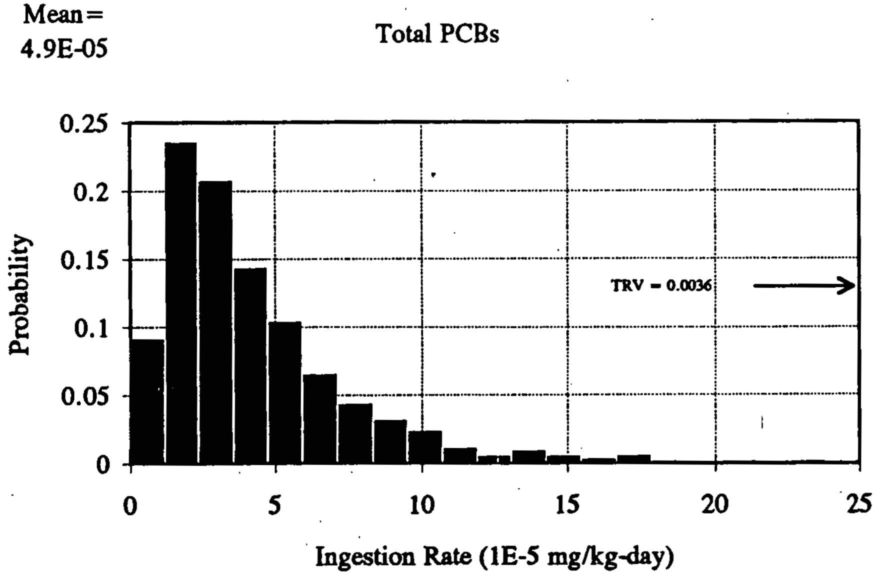
Mean=
1.6E-04



Mean=
2.7E-03



Mean=
4.9E-05



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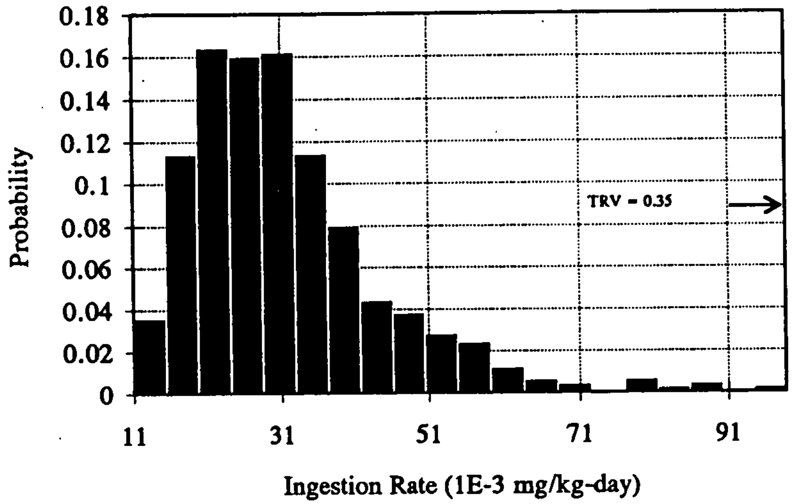
Results of Ingestion Rate Simulation Modeling
for Mule Deer
Figure E6-6B

FE6-6.XLS 5/20/94

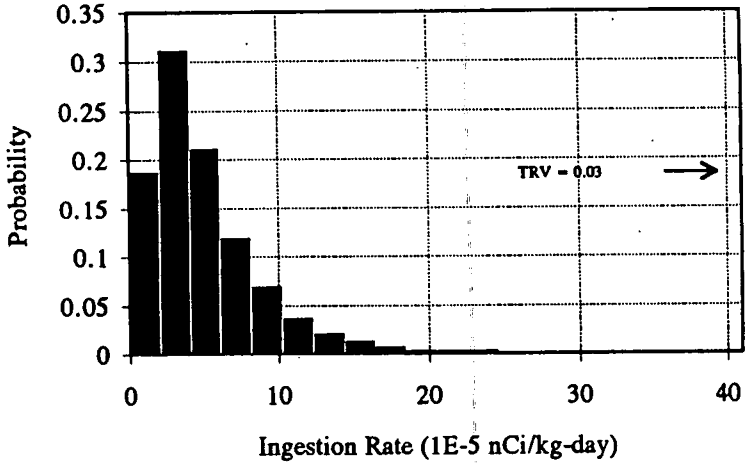
Mean =
3.3E-02

Selenium



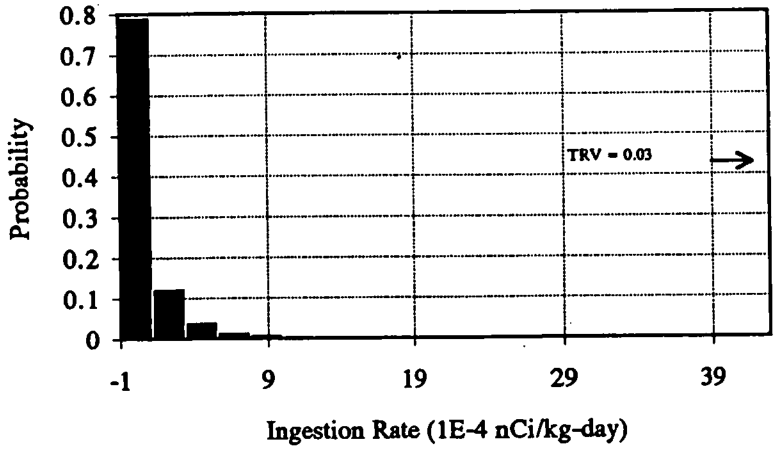
Mean=
5.5E-05

Plutonium- 239,-240



Mean=
1.6E-04

Americium - 241



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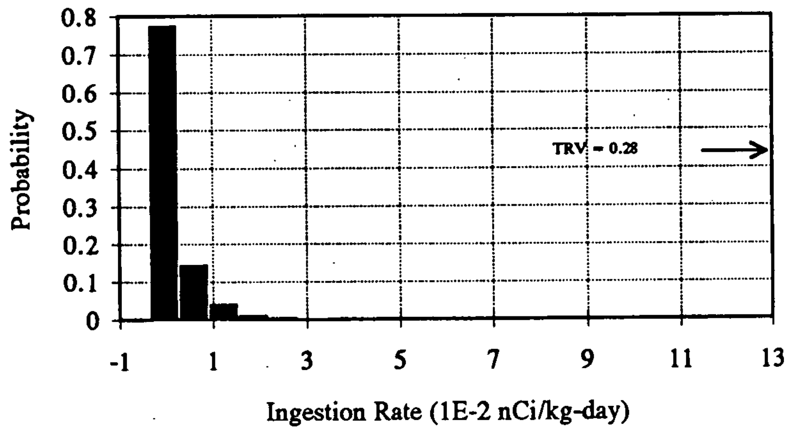
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Coyotes
Figure E6-7A

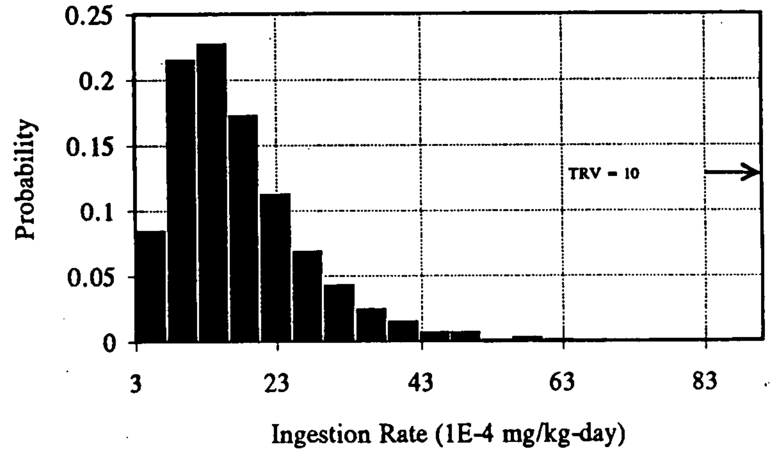
Mean=
4.5E-02

Uranium (total)



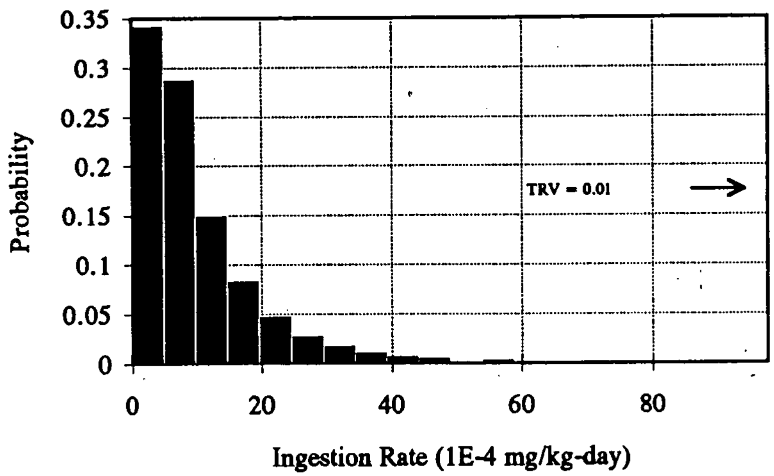
Mean =
1.8E-03

Benzo(a)pyrene



Mean=
1.1E-03

Total PCBs



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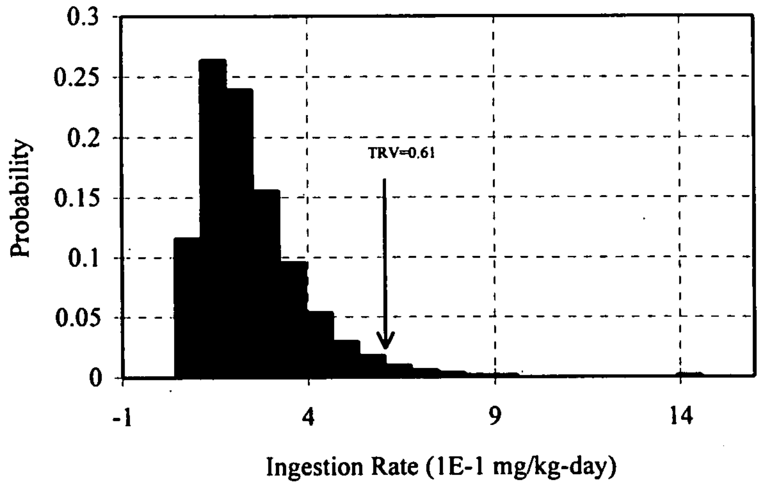
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Coyotes
Figure E6-7B

FE6-7.XLS 5/20/94

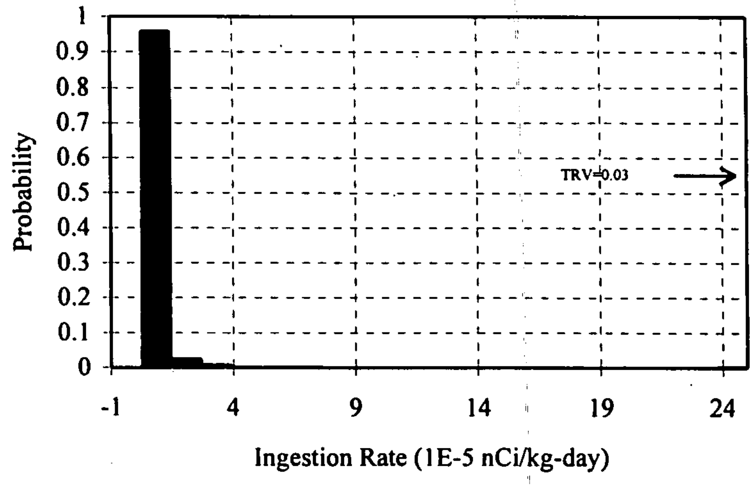
Mean=
2.6E-01

Selenium



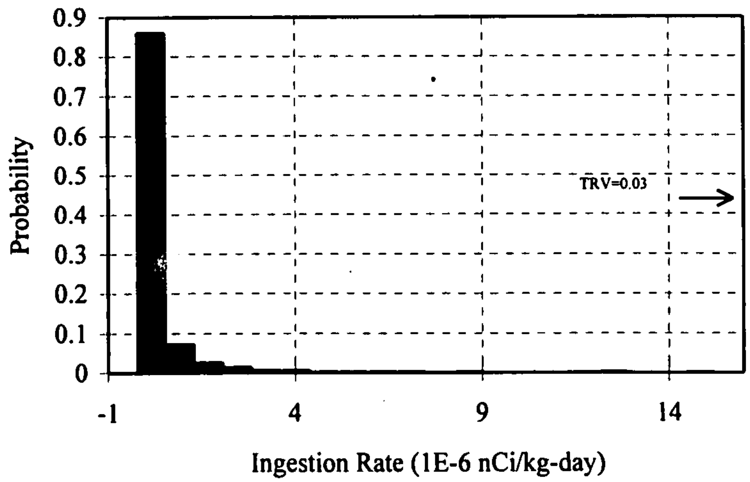
Mean=
3.0E-09

Plutonium-239,-240



Mean=
4.7E-10

Americium-241



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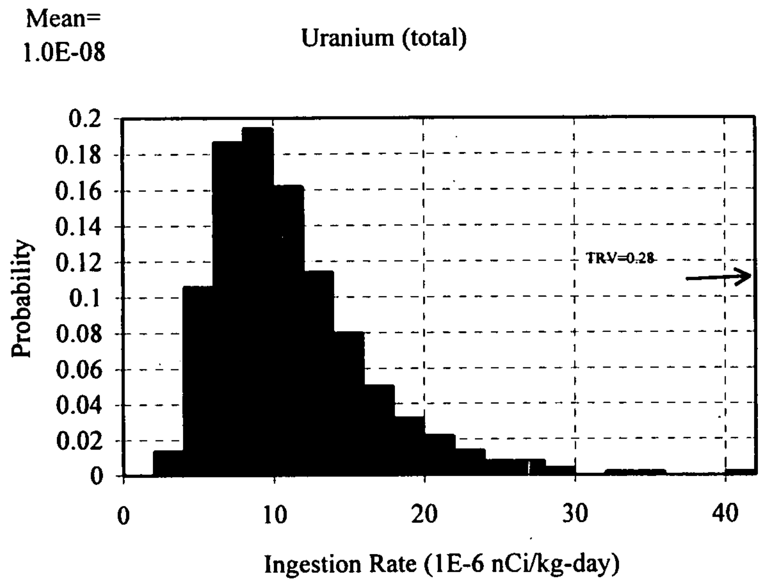
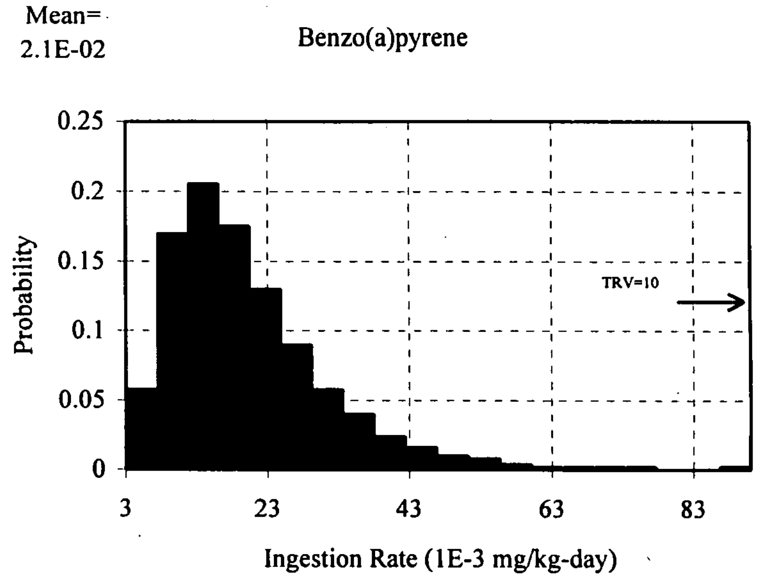
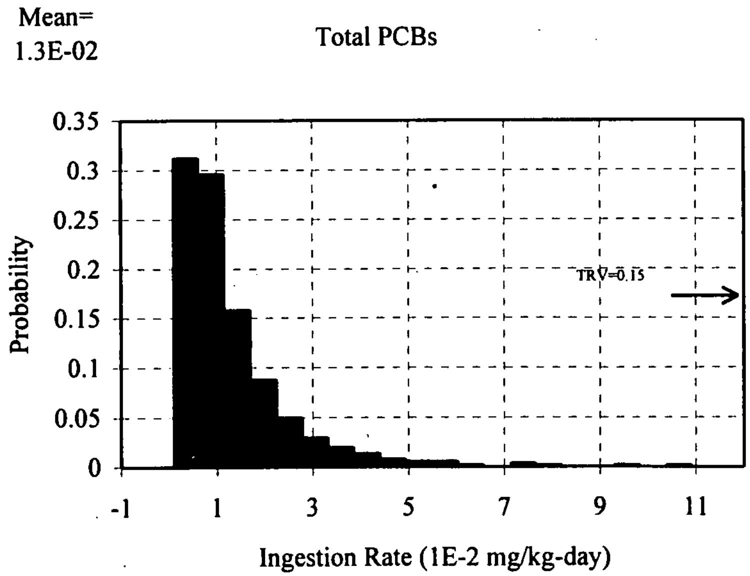
881 HILLSIDE AREA
OPERABLE UNIT NO. 1
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Red-tailed Hawk
Figure E6-8A







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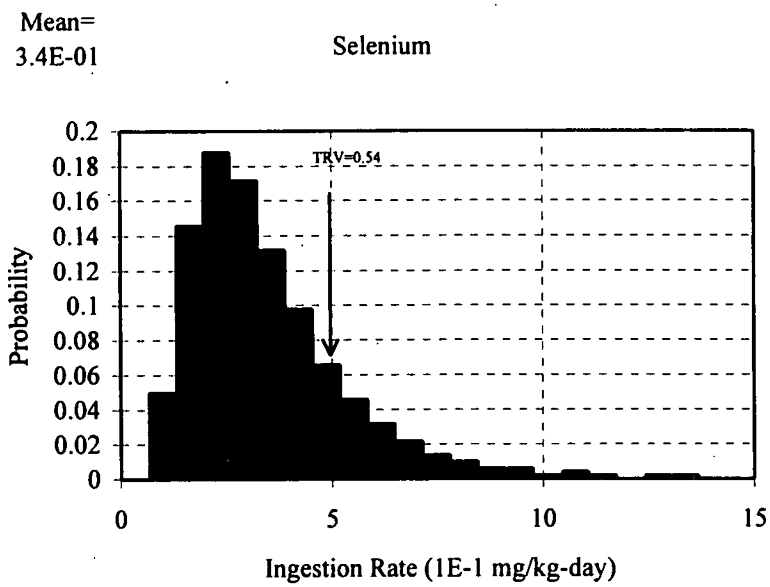
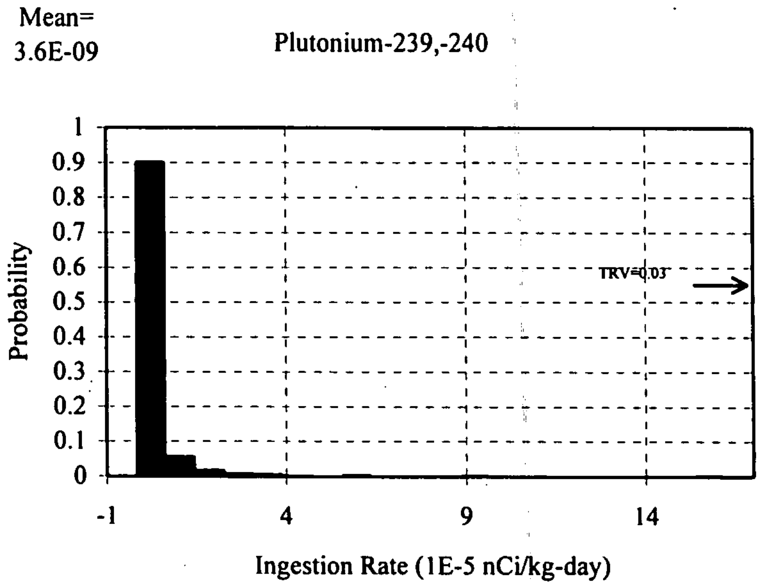
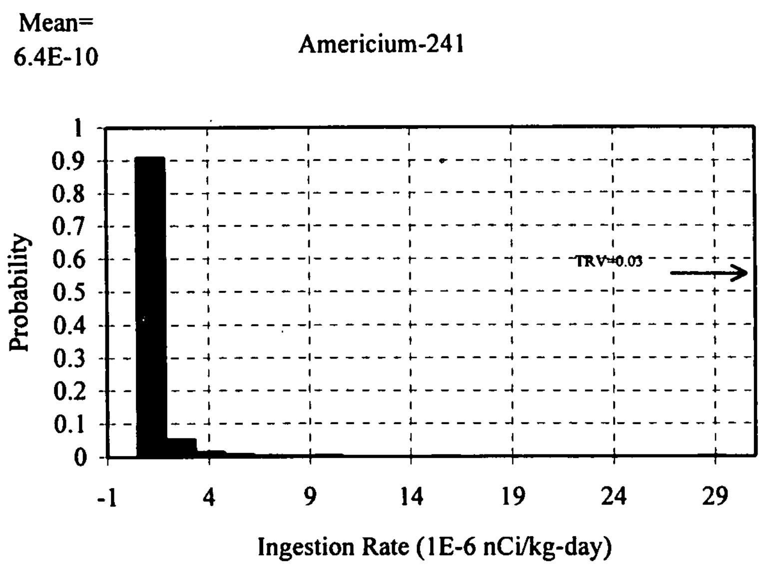
881 HILLSIDE AREA
OPERABLE UNIT NO. 1
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Red-tailed Hawk
Figure E6-8B







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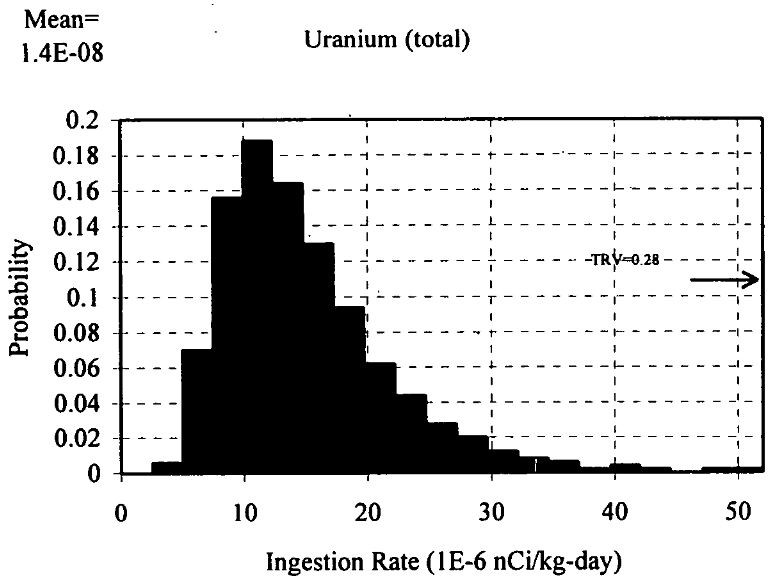
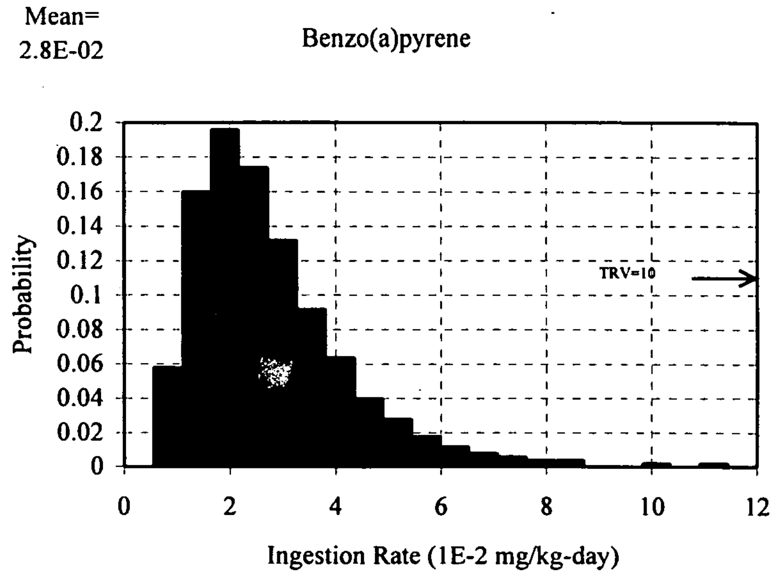
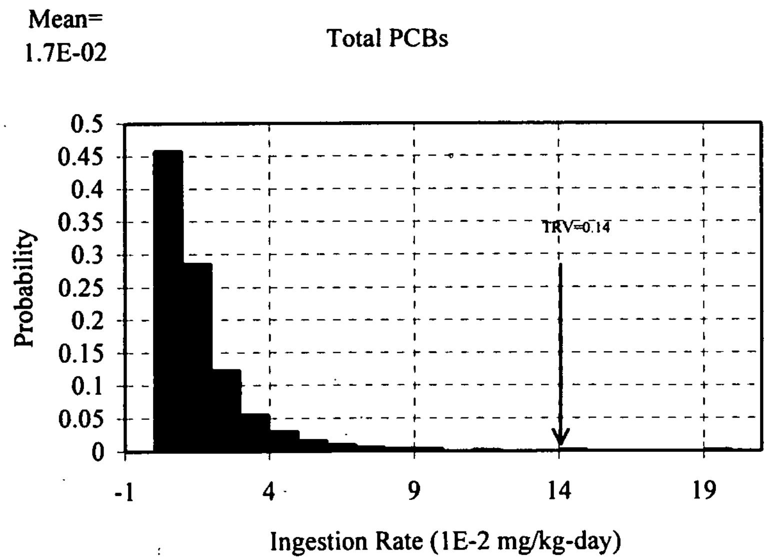
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Great Horned Owl
Figure E6-9A

FE6-9.XLS 5/







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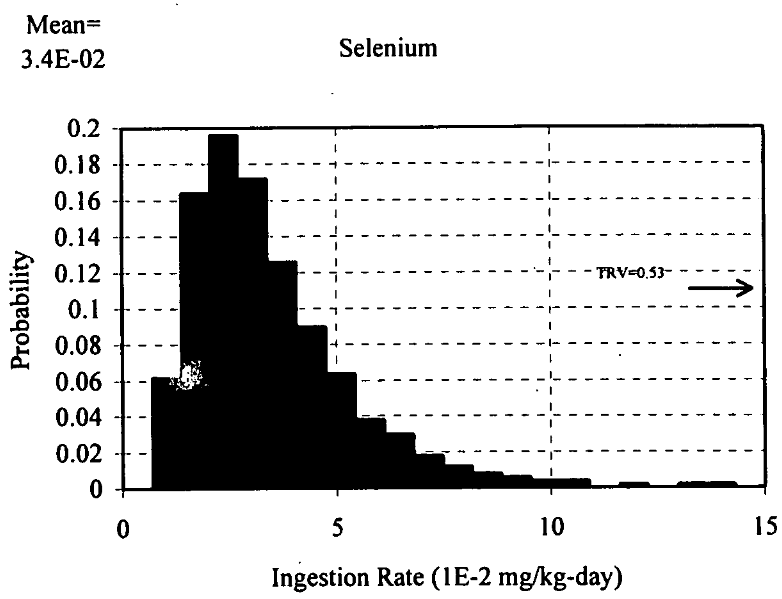
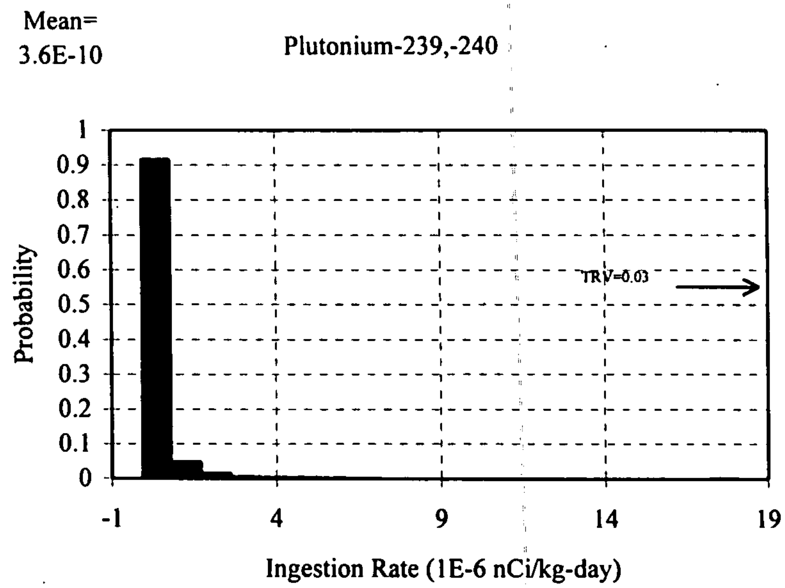
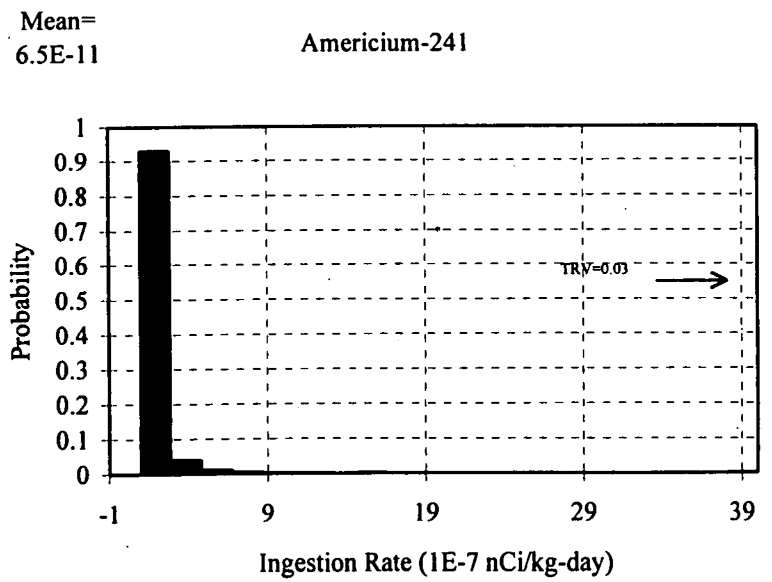
881 HILLSIDE AREA
OPERABLE UNIT NO. 1
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Great Horned Owl
Figure E6-9B

FE6-9.XLS 5/18/94







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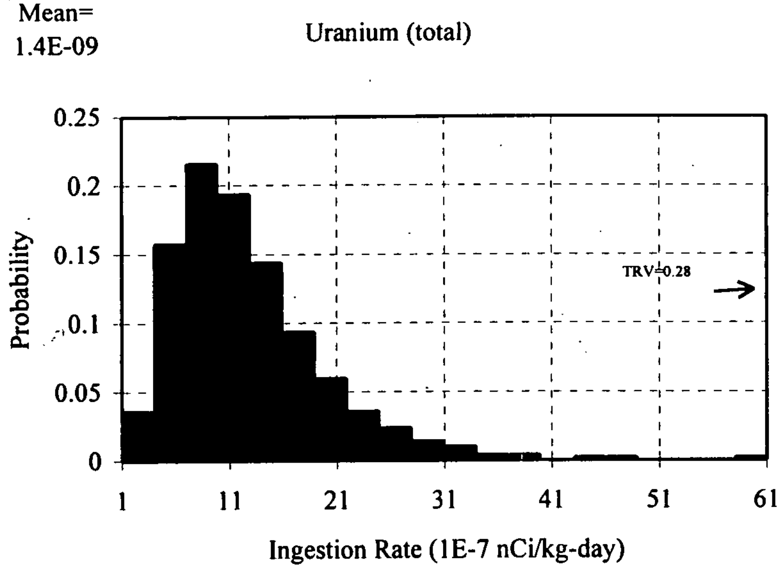
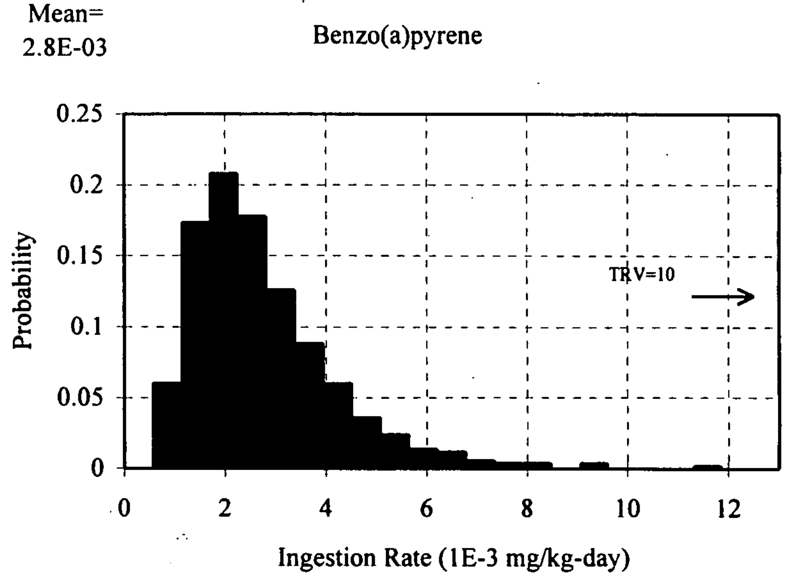
PHASE III RFI/RI REPORT
Results of Ingestion Rate Simulation Modeling
for Bald Eagles
Figure E6-10A

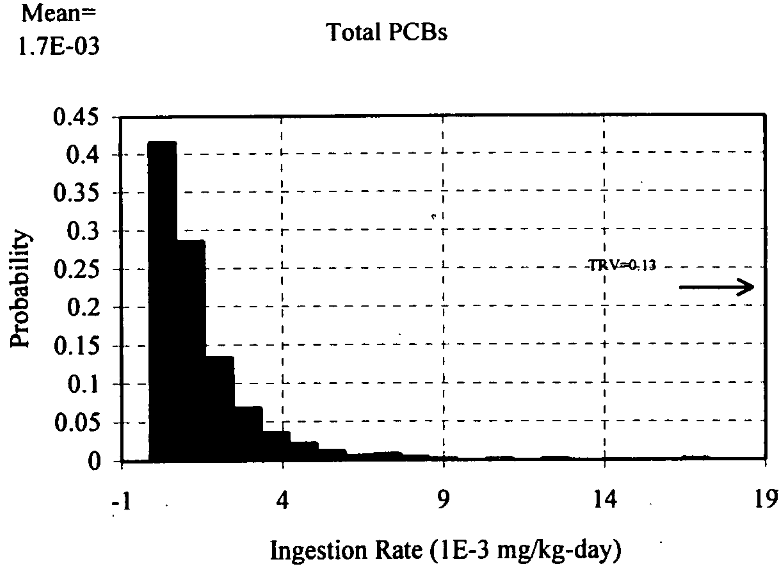
Mean=
1.4E-09



Mean=
2.8E-03



Mean=
1.7E-03



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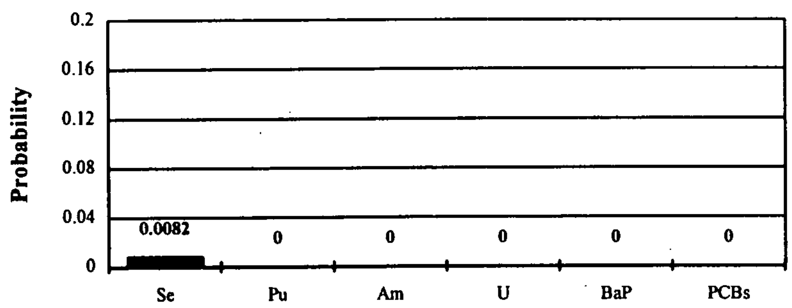
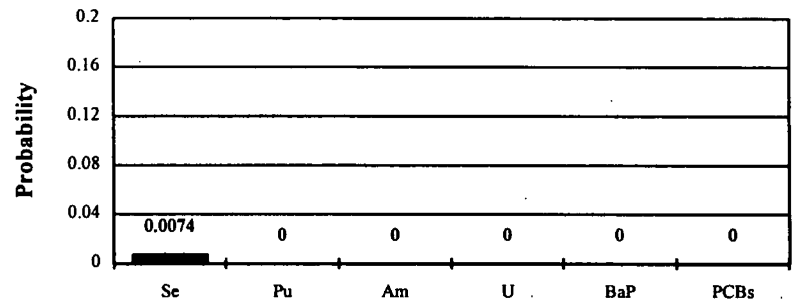
Results of Ingestion Rate Simulation Modeling
for Bald Eagles
Figure E6-10B

FE6-10.XLS 5/18/94

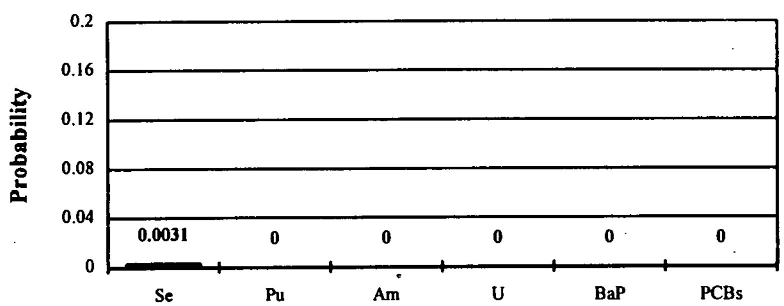
Deer Mouse



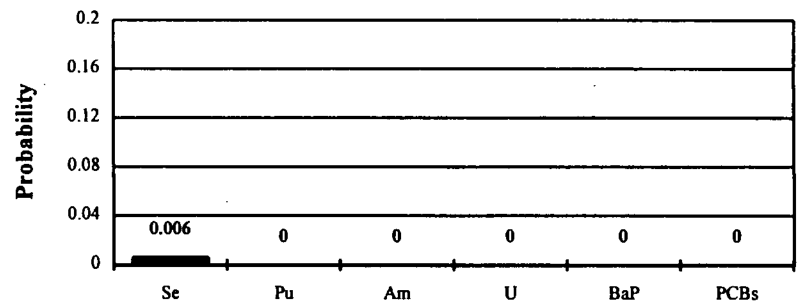
Meadow Vole and Prairie Vole



Meadow Jumping Mouse



Mule Deer



Se: Selenium
Pu: Plutonium
Am: Americium
U: Uranium
BaP: Benzo(a)pyrene
PCBs: Polychlorinated Biphenyls

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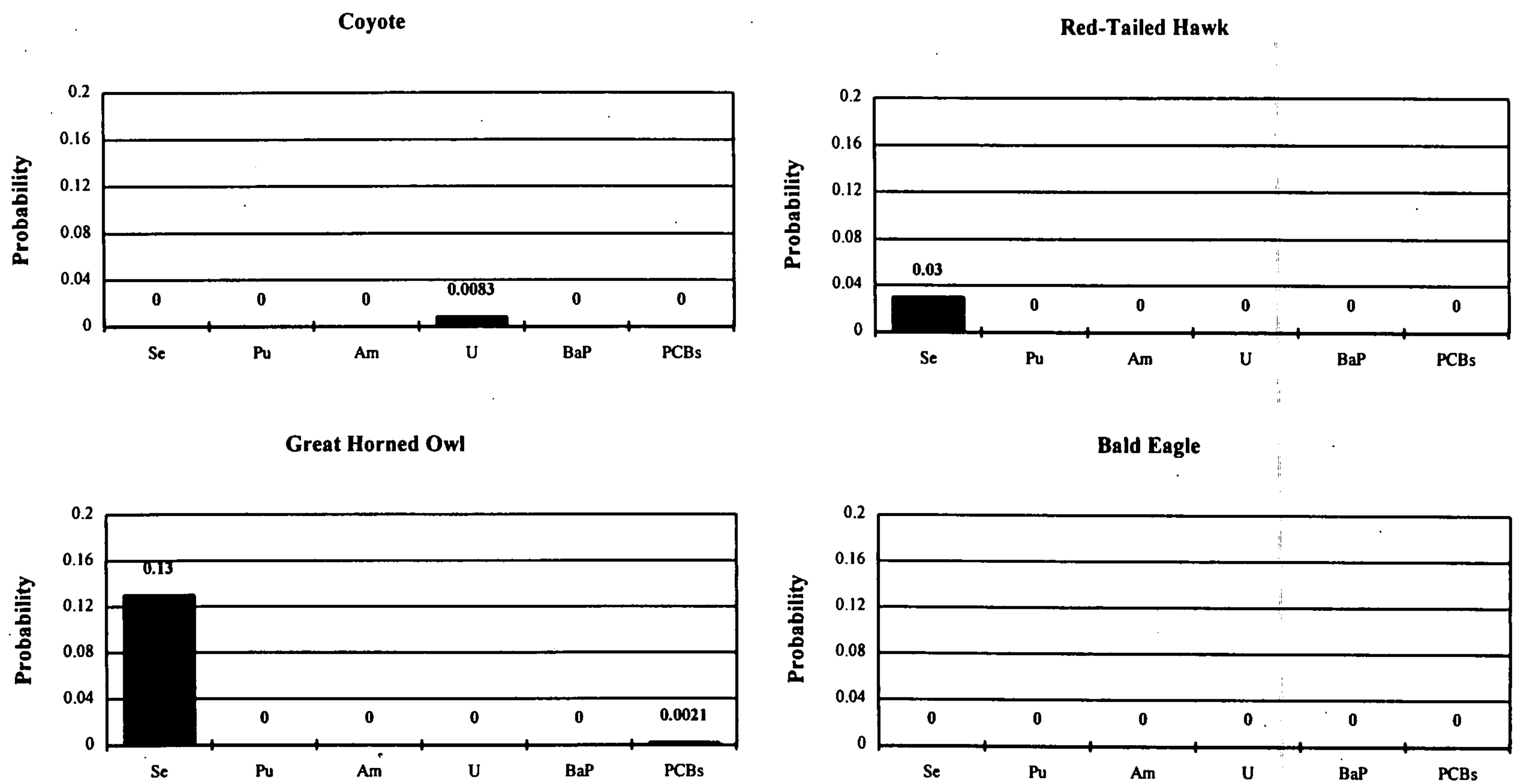
PHASE III RFI/RI REPORT

PROBABILITY OF EXCEEDING INGESTION RATE TRV
Figure E6-15A

\2550604\FE6-15.XLS



Se: Selenium
Pu: Plutonium
Am: Americium
U: Uranium
BaP: Benzo(a)pyrene
PCBs: Polychlorinated Biphenyls

U.S. DEPARTMENT OF ENERGY
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PROBABILITY OF EXCEEDING INGESTION RATE TRV
Figure E6-15B

\2550604\FE6-15.XLS

SECTION E7

CHARACTERIZATION OF ECOLOGICAL EFFECTS

The purpose of this section is to describe the ecological conditions within OU1 as they relate to potential contamination arising from OU1 IHSSs. The assessment of ecological condition was based on a qualitative and quantitative assessment of plant and animal community composition. The study was initially designed to determine impacts through comparison of ecological data from OU1 to that from a relatively unimpacted reference area in the Rock Creek drainage. Reference sites were chosen based on visual inspection prior to collection of quantitative data. Sampling was stratified by habitat type in both reference and study areas to facilitate the analysis and interpretation of data. The distribution and extent of habitat types were discussed in Section E2.2.

Quantitative comparisons between study and reference areas were used wherever applicable and appropriate. Qualitative assessments were used to characterize habitat distribution, relative importance of habitats in OU1, and use of the OU1 area by wildlife. As noted in Section E1, ecological characterization was limited to general indicators of ecological community health because the nature of the contaminants was unknown prior to field investigations. Direct measure of contaminant effects was limited to measure of toxicity of surface water in Woman Creek using standard toxicity test organisms.

Section E7.1 describes the selection of reference area sites. Section E7.2 describes the endpoints and data collection methods for community, tissue, and toxicological sampling. Section E7.3 describes the results of field and toxicological investigations.

E7.1 SELECTION OF REFERENCE SITES

The initial design of the OU1 EE field sampling included comparison of sites within OU1 with those in an unimapacted reference area to: (1) determine impacts to ecological communities and (2) to estimate background levels of naturally occurring COCs in biological tissues. Reference areas were identified based on visual inspection of prospective areas and application of criteria developed in conjunction with EPA and the Colorado Department of Health (CDH) and described in the OU1 FSP (DOE, 1991b). The Rock Creek drainage in the northern portion of RFP was selected for sampling because it was close enough to the OU1 study area to share similar geochemistry, historical land use, and biological communities; but remote enough to be unimpacted by industrial activities at RFP. Specific traits of Rock Creek that made it an appropriate choice for location of reference sites include the following:

- **Geographic Proximity**—The main stem of Rock Creek is approximately 1 mile north of the segment of Woman Creek adjacent to OU1.

- **Geochemistry**—The headwaters of these two drainages are both located in the upper terrace of Rocky Flats alluvium and within the RFP boundary. Naturally occurring metals were included in the preliminary target analytes for the OU1 EE. It was important that the baseline measurements be taken from populations exposed to background levels of metals similar to those in OU1. RFP site-wide background concentrations for abiotic media were established using data from the Rock Creek drainage and it was considered advantageous that background biota samples be obtained from the same area.

- **Land Use**—Neither the Woman Creek nor Rock Creek drainage has been grazed by livestock for a period of more than 20 years. Potential off-site reference areas are either currently grazed or have been grazed in the recent past. Livestock grazing can severely alter sedimentation rates and input of organic matter into a stream, thus altering water quality and ecological structure. In addition, both drainages have been relatively protected from development. Most other drainages in the area have been subject to development in upstream segments.

- **Vegetation**—Because neither of the drainages has been under grazing pressure, the overall vegetation of the riparian areas is similar. Dense stands of sandbar willows and leadplant border extensive segments of both creeks. Upper slopes and terraces in the Rock Creek area are dominated by the same grassland vegetation types as those along Woman Creek

- **Stream Order**—In the segments in question, both Woman Creek and Rock Creek are first-order, headwater streams.

- **Minimal Impacts from RFP**—Rock Creek is generally considered upgradient and upwind of RFP and therefore less likely to have received contaminants from affected areas. Areas of the buffer zone southeast of the industrial area also support native communities, but may be subject to wind-borne transport of site contaminants.

Off-site areas also were considered but not sampled because: (1) areas in the Rocky Flats Alluvium and near RFP were either heavily grazed and therefore had plant communities that differed from the native communities at RFP, and (2) the areas may have different geochemistry which would affect evaluation of effects for heavy metal contaminants.

Terrestrial and aquatic habitats in the Rock Creek drainage were identified and mapped as part of the site-wide Baseline Biological Characterization of the Terrestrial and Aquatic Habitats (DOE, 1992b). Habitats within the reference area were identified according to OPS EE.11 (EG&G, 1991). Within these habitats, reference sites were selected to serve as locations for sampling terrestrial vegetation, wildlife, aquatic invertebrates, and fish (Figure E7-1).

Sampling of terrestrial and aquatic habitats in the reference areas was conducted in conjunction with sampling at OU1 and OU2 in 1991. In 1993, EPA reviewed the resulting data from Rock Creek and OU1 to determine the suitability of comparisons for purposes of assessing impacts. EPA accepted the sites used for terrestrial evaluation but rejected Rock Creek for use as a reference area for assessment of aquatic life. A detailed description of terrestrial reference areas is presented in Section E7.1.1. An explanation of aquatic reference area rejection is provided in Section E7.1.2.

E7.1.1 Terrestrial Reference Sites

Terrestrial reference sites were selected based on their comparability to OU1 in terms of both physical and biological characteristics. As required by OPS EE.13, consideration was given to habitat type (dominant vegetation), habitat size, slope, and aspect, for terrestrial habitat sites (Table E7-1). Soil type was not evaluated as a selection criterion because it is reflected in the composition of the vegetation community. Since sampling in OU1 was stratified by habitat type, reference sites were selected for each habitat.

- **Marshland (Wetland)**—Marshland study sites were chosen to represent the diversity of wetland types within OU1. Marshland communities in OU1 range from wet meadow to cattail marsh and in many cases as well developed. All OU1 marshlands are artificial and result from construction of drainage systems, diversion ditches, and impoundments. The development of artificial wetlands differs from natural ones and the result in significant vegetational differences were obvious that are independent of potential contamination. Thus, the Rock

Creek marshland reference sites are appropriate for only qualitative comparison to OU1.

- **Mesic Grassland**—Mesic grassland is the most widespread community type in OU1. The mesic grassland reference sites are directly analogous to study sites across all selection criteria and are therefore appropriate for both quantitative and qualitative comparisons with OU1 sites.

- **Xeric Grassland**—Xeric grassland is extremely limited in extent on the OU1 study area. The reference areas selected adequately represent the range in plant community, slope, aspect, and soil type of the native xeric grasslands at Rocky Flats. Thus, quantitative and qualitative comparisons between the xeric grassland reference and study sites are appropriate.

- **Riparian Woodland**—Riparian woodland reference areas along Rock Creek were directly comparable to Woman Creek in terms of slope, aspect, community type, and soil type, with one exception: OU1 study site MW01A was a hillside woodland community. This community is poorly represented in the Rock Creek drainage, and no analogous reference area could be found. However, MW01A was destroyed during construction of the French Drain, rendering the comparison moot. As with marshland, differences in habitat structure unrelated to potential contamination or physical disturbance limit quantitative comparisons, although qualitative assessments are appropriate.

- **Disturbed Land and Reclaimed Grassland**—Reference areas were not selected for disturbed or reclaimed communities because they were not represented in the Rock Creek drainage. Moreover, the characteristics of disturbed or reclaimed areas tend to be profoundly affected by physical conditions that would mask all but the most dramatic contamination effects. Natural recovery from disturbance occurs through a progressive shift in community composition referred to as plant succession. Therefore, comparisons of disturbed communities are not useful for the purpose of the EE because differences are likely to reflect successional stage as site conditions. Disturbed areas are often "reclaimed" by planting perennial grasses to stabilize soils. The grasses used are usually aggressive non-native species that persist for many years and inhibit invasion by native species. Because of their anthropogenic origins, reclaimed communities are not valid for comparison with either native grassland or other reclaimed areas.

A total of 16 small mammal reference sites were established: four in mesic grassland, four in xeric grassland, four in marshland, and four in riparian woodland. Vegetation was sampled at each small mammal site. In addition, five bird transects were selected to serve as reference sites: one in mesic grassland, two in xeric grassland, one in marshland, and one in riparian woodland.

Differences Between Study Sites and Reference Sites

Although reference sites were selected to be as comparable to study sites as possible, these were not paired in a one-to-one fashion due to the variable size and geometry of each habitat type. Also, as noted previously, disturbed land and reclaimed grassland habitats had no counterparts in the reference area.

These differences were considered tolerable for purposes of this study. For relatively mobile animal groups, minor differences between study sites and reference sites for a particular habitat type would not be reflected in substantive differences in species presence, diversity, relative abundance, reproductive success, or population density. For plants that are not mobile minor differences between study sites and reference sites in a particular habitat could contribute to variability in measurement endpoints of community structure. Plant cover and production sampling were each structured to statistically quantify this variability. Variance calculations provide a basis for understanding the causes of variability by comparing its magnitude within and between study and reference site data sets. The similar geochemistry and soils types of the areas make them suitable for use in assessing background levels of naturally occurring chemicals in biological tissues.

E7.1.2 Aquatic Sites

Potential study sites were chosen on Woman Creek upgradient, downgradient, and adjacent to OU1. In accordance with OPS EE.13 (EG&G, 1991), flow regime, depth, current velocity, substrate type, and amount of shading of the channel were assessed for study sites, and similar sites were then sought on Woman Creek upstream of OU1 and on Rock Creek (Table E7-2). Wherever possible, the sites were collocated with established RFP surface water quality monitoring locations because historic data on water quality were available from these sites.

The physical characteristics of the Rock Creek sites match well to Woman Creek sites in all areas except flow which is probably the major factor limiting ecological structure in both creeks. Woman Creek includes more segments of persistent flow than Rock Creek, especially during mid to late summer. Therefore, Rock Creek may be expected to exhibit diminished species richness, abundance, density, and biomass.

In 1993, EPA personnel reviewed the information in Table E7-2 and data from benthic macroinvertebrate sampling conducted in 1991 at Rock Creek and Woman Creek sites. Based on this review, EPA determined that the Rock Creek sites did not represent appropriate reference sites for evaluation of the benthic community in Woman Creek. Therefore, evaluation of potential impact of OU1 on the aquatic community in Woman Creek was based on comparisons of sites adjacent to OU1 and sites upstream of OU1.

The use of metals concentrations for biota tissue from Rock Creek is believed to be appropriate. Fish tissue from Lindsay Pond, a permanent pond along the southern tributary of Rock Creek, was used to estimate background levels. This pond has more emergent vegetation and a higher density of benthic flora than either Pond C-1 or C-2. This higher amount of organic content would tend to reduce the load of available metals in the water or sediment. Therefore, metal content of fish or benthic tissue collected from this pond may be lower than in ponds with the same geochemistry, but lower organic content, such as Pond C-1 or C-2.

E7.2 METHODS

E7.2.1 Ecological Investigations

Ecological field investigations were conducted primarily during spring, summer, and fall of 1991. Additional studies during the following winter months focused primarily on relative abundance and general habitat use by terrestrial vertebrates. The purpose of the field investigation was to characterize and, where possible, quantify the terrestrial and aquatic habitats within the OU1 ecology study area and the reference area. Terrestrial sampling was stratified by the six habitat types found in OU1: mesic, xeric, and reclaimed grassland; marshland, riparian complex, and disturbed land (see Section E2.2 for a complete description of habitat types).

Aquatic habitats in Woman Creek were sampled during ecological investigations. However, impacts to aquatic systems from OU1 contaminants were not evaluated quantitatively because contaminant sources in OU2 (903 Pad, Mound, East Trenches) and OU5 (Woman Creek Priority Drainage) also could affect the stream community. IHSSs in these two OUs probably contain similar contaminants. Therefore, it would be difficult to attribute impacts specifically to OU1 sources. Through agreement with EPA and CDH, quantitative evaluation of impacts to the aquatic community in Woman Creek will be carried out during the OU5 Phase I RFI/RI.

Specific methods employed in ecological (community) studies of target ecosystem components are described below.

E7.2.1.1 Vegetation

Terrestrial vegetation is one of the simplest ecosystem components to study quantitatively because the organisms are immobile, sampling techniques are relatively objective, and large sample sizes can be readily obtained. Plants may also be good indicators of contamination or physical disturbance because they are totally dependent on conditions at the site where they occur. Plants are the direct food source for herbivores and, because they provide food and cover for invertebrates and small vertebrates, the indirect food source for avian and mammalian predators. However, interpretation of community data can be difficult. Numerous minor variables not associated with contamination or disturbance can have profound influences on species dominance.

Measurement endpoints for the OU1 vegetation community analysis were basal cover, species richness, production, woody plant density, cacti density, and diversity. All but diversity (a calculated index) were based on direct measurements made along transects located within each of the six plant communities using methods specified in OPS EE.10 (EG&G, 1991).

Basal cover estimates the portion of the soil surface that is occupied by emerging vegetation and is expressed as a percentage. Basal cover was measured using the point-intercept method. Cover was recorded at 100 paired points (basal "hits") along 50-meter transects. A steel rod was lowered vertically to the ground at each point and if the current year's growth for a plant species was intercepted, it was recorded by species. Any other interception was recorded as appropriate: litter (dead remains of previous years' growth), soil, or rock.

Species richness (the number of species within a sampled area of a community) and density of woody plants and cacti were measured using the belt-transect method. Investigators recorded all species present within a 2-meter by 50-meter (100-m^2) belt centered on a cover transect. Densities of woody plants and cacti were estimated by counting the number of individuals, by species, within the belt transects.

Production is an expression of the total standing biomass of a species per unit area. Production was estimated by clipping aboveground, current year's growth from five 0.25-m^2 plots located along the cover transects. The clipped plant material was sorted by species (except for minor species, which were combined), dried, and weighed.

Species diversity was calculated using the Shannon-Weaver diversity index (Ludwig and Reynolds, 1988). This measure of diversity reflects both the number of species within an area (richness) and the relative dominance among species (equitability or evenness).

Cover and richness data were collected during both late spring/early summer (May through June) and late summer/early fall (August through September). Production data were collected only during the late summer/early fall. Cover data from only the second sampling period were used for quantitative descriptions of habitat types and statistical comparisons between study and reference areas. Late summer/early fall cover data are a more accurate indicator of overall community structure because both warm-season and cool-season grasses, as well as the larger forbs, have reached their full expression. Cover and richness data collected during the late spring/early summer sampling period were used primarily to document the presence and relative abundance of spring-flowering forbs and to refine the sampling scheme. The distribution of vegetation community types and sampling locations for the reference and study areas are shown in Figures E7-1 and E7-2, respectively.

E7.2.1.2 Small Mammals

Small mammals were included in quantitative studies because they live in contact with the soil, may ingest contaminants through their plant or invertebrate food, occupy small home ranges throughout their lives, and are the key prey for many predators. Small mammals were live-trapped during late spring and early fall of 1991. Trapping was performed at four sites in each habitat type, except xeric mixed grassland in the study area which was large enough for only one site. At each sampling location, trapping was performed over a period of four nights using methods specified in OPS EE.6 (EG&G, 1991). Twenty-five Sherman live-traps were set in five-by-five grids, with 5 m between traps. Traps were baited with a molasses-based horse feed. Cotton balls were placed in each trap to provide bedding material. Captured individuals were marked with food coloring so that recaptures could be differentiated from new captures on subsequent nights.

Measurement endpoints for small mammals were species richness (number of species per trapping grid) and relative abundance (number of individuals by species per 100 trap-nights). Data on weight, sex and age class, and reproductive status were recorded but were not deemed to be appropriate for statistical evaluations of ecological differences between study and reference areas. To assist in data interpretation, small mammal plots were collocated with vegetation transects. Trapping locations for the study area and reference area are shown in Figures E7-3 and E7-4, respectively.

E7.2.1.3 Terrestrial Arthropods

Terrestrial arthropods, which consist primarily of insects and arachnids (spiders), are similar to small mammals as indicators of ecological health because of their contact with the soil, consumption of plant material (or other invertebrates), and importance in the prey base. Terrestrial arthropods were sampled along 50-meter transects collocated with the vegetation cover transects. Three transects were sampled for each of the habitat types, except xeric mixed grassland in the study area, which had only one transect because of limited areal extent. Sampling was performed on three separate occasions (once each in July, August, and September 1991) during daylight hours. Measurement endpoints for terrestrial arthropods included taxon richness (number of orders and families per transect) and relative abundance (number of individuals per transect).

Sampling was performed using sweep nets and pitfall traps; opportunistic netting was used to collect lepidopterans (butterflies and moths). Individuals were preserved in alcohol in the field and taken to the laboratory for identification and enumeration. All arthropod sampling was performed in accordance with OPS EE.9 (EG&G, 1991).

E7.2.1.4 Benthic Macroinvertebrates

Benthic macroinvertebrates may serve as important indicators of water quality and ecological health in streams for which surface flows are sufficient to maintain a functioning community. These organisms live in intimate contact with contaminants in the water or sediments and are an important exposure pathway to predatory fishes or piscivorous birds via the aquatic food web. Because of their potential value as indicators of stream health, benthic macroinvertebrates are often used to assess impacts of contamination (Hilsenhoff, 1982; Ohio EPA, 1989; EPA, 1989d; Novak and Bode, 1992).

Benthic macroinvertebrates, consisting primarily of aquatic insect larvae and crayfish, were sampled in spring and fall 1991 at Ponds C-1 and C-2, at six locations along Woman Creek (including four riffles and two pools), and on the small rivulet emanating from Antelope Spring (see Figure E7-5). All benthic macroinvertebrate sampling was performed in accordance with OPS EE.2 (EG&G, 1991). Organisms were identified to the lowest practicable taxonomic level. Water quality parameters were recorded at each of the sampling sites to aid in data interpretation.

At each of the two impoundments, five sediment samples were collected from the following locations: the deepest point, midway between the deepest point and the inlet, midway between the deepest point and the outlet, and two points on either side of the impoundment's long axis. At each sampling location, a composite volume of at least 2,000 cubic centimeters (cm^3) of sediment was obtained by combining a minimum of four subsamples collected with a Peterson dredge.

Stream reaches were sampled using Surber samplers. In areas of low current velocity, debris such as cobbles and sticks was carefully removed from the sampler and placed in a large plastic tub. Organisms adhering to the debris were then carefully brushed or washed off the debris and placed into the sample container. At each sampling site, subsamples were collected from five sites within a 10-m stream segment.

Measurement endpoints for benthic macroinvertebrates included the following:

- Taxa richness (number of taxa per location)
- Relative abundance (number of individuals by taxon for each location)
- Tolerance to organic pollutants (Hilsenhoff family biotic index [FBI])
- Functional feeding groups (scrapers versus filterers and collectors)
- EPT richness (number of taxa in the Ephemeroptera, Plecoptera, and Trichoptera at each location)
- EPT/Chironomid ratio
- Percent contribution of dominant family
- Community similarity (Jaccard's index)

These metrics are included in EPA's Rapid Bioassessment Protocol (RBP) III (EPA, 1989d). However, the formal RBP III protocols were not used because neither an unimpacted site nor a regional database was available for comparison. Assessment of impacts due to OU1 sources was made by comparing data from sites adjacent to or downstream of OU1 to sites upstream of OU1 on Woman Creek.

The FBI is based on the Hilsenhoff Biotic Index (HBI)(Hilsenhoff, 1987). The HBI was formulated for evaluating organic contamination in midwestern streams. The index has not been fully evaluated for non-organic contaminants or for streams in the western United States. The index is included here to support the weight of evidence approach.

E7.2.1.5 Fish

Fish are indicators of water quality and the health of the aquatic food web and are potentially important vectors of contamination from aquatic to terrestrial ecosystems. Fish were sampled during spring and fall 1991 in the two ponds and the reach of Woman Creek shown in Figure E7-5. Minnow traps were set for a minimum of three nights at each location considered capable of supporting fish. Gill nets were used in the ponds to sample larger species and individuals. Electrofishing was performed along Woman Creek on one occasion in order to provide a more thorough sampling than was possible with the minnow traps. All sampling protocols were conducted in conformance with OPS EE.4 (EG&G, 1991).

Measurement endpoints included species richness (number of species present in each pond or the Woman Creek study reach) and relative abundance (number of individuals, by species, captured at each location). Additional data recorded during the fall sampling period included length, weight, and age class. Fish also were examined for signs of disease, parasites, or deformities.

E7.2.2 Ecotoxicological Investigations

E7.2.2.1 Collection of Biological Tissue Samples

Tissue contaminant loads are generally reliable indicators of exposure to chemicals that tend to bioaccumulate, but are less reliable for chemicals that are rapidly metabolized and/or excreted (EPA, 1989b; Suter, 1993). Biological tissue samples were collected and analyzed to support the exposure assessment component of the OU1 EE. Samples were collected from OU1 and the reference area, and the analytical results were compared to determine if uptake of contaminants was greater in the affected areas. Tissue analytes were chosen from the preliminary list of COCs developed in 1991 (Table E4-1). Tissues were analyzed only for those chemicals that were known to bioaccumulate, and for which no MATC or other standard was available (DOE, 1991a). Results are presented for only those analytes that were included in the final COC list (Table E4-5).

Species to be collected for tissue analysis were selected on the basis of criteria developed by EG&G in conjunction with DOE, EPA, and CDH. These criteria specified that taxa sampled for tissue (destructive) sampling must have been potentially affected by the COC in a manner that can be measured in tissues, have a reasonable home range with respect to the potential contamination, and meet all of the following:

- The species are not an endangered or threatened species.
- Local populations were sufficient to support collection without producing direct adverse effects.
- The species must have been known to accumulate the particular COC, or to demonstrate the effects of the COC, in a manner that can be assessed by tissue sampling.

Vegetation species collected for tissue analysis included common grasses and forbs found throughout Rocky Flats. A minimum of one grass and one forb sample was collected at each site. Samples included aboveground biomass of at least two individual plants and weighed at least 30 grams (fresh weight).

Animals collected for tissue analysis were terrestrial arthropods (grasshoppers), small mammals, and fish. Species collected had to be of sufficient size and abundance to meet the minimum sample mass of 25 grams. Grasshoppers were the only terrestrial arthropod for which samples could be collected efficiently. Deer mice, meadow voles, and prairie voles were collected to represent small mammals. These species are found site-wide in sufficient abundance to support the sampling effort and are important components of the prey base. Fish species collected included fathead minnows, creek chubs, white suckers, green sunfish, and largemouth bass. These were selected based on presence and abundance at the various aquatic sampling sites.

Whole body samples were collected for two reasons. First, much of the available toxicity information is based on whole body measurements (Eisler, 1986, 1987; Maughan, 1993; Suter, 1993). Second, most small prey are consumed whole, and therefore the predator ingests all contaminant contained in or adhering to its food. All tissue samples were collected, preserved, and shipped according to standard procedures at Rocky Flats (EG&G, 1991). Results of tissue sampling are summarized in Section E6.3.

E7.2.2.2 Aquatic Toxicity Screen Methodology

Aquatic toxicity tests were conducted to determine whether gross toxicity was introduced into Woman Creek in areas adjacent to or downgradient from OU1. Ten sites were sampled in the Woman Creek drainage (Figure E7-6). Two of the sites, SW041 and SW039, are on the main stem of Woman Creek but upstream of OU1. SW104 is a spring on a hillside south of Woman Creek. SW033 and SW032 are on the main stem of Woman Creek and adjacent to the extreme western edge of the OU1 area. SW032 is just downstream from the confluence of Woman Creek and the rivulet flowing from SW104. WORI3 and WORI1 are on the main stem of Woman Creek upstream and downstream of Pond C-1, respectively. WOPO2 is downstream of OU1, about 100 meters west of Indiana Avenue. Pond C-1 (SW0C1) is an impoundment on Woman Creek directly south of OU1. Pond C-2 (SW0C2) is an impoundment that receives flow from the SID. Woman Creek is diverted around Pond C-2 (Figure E7-6). Three other sites not on Woman Creek but in the RFP buffer zone were also sampled to assess "background" toxicity of surface water. SW005 is in the upper reaches of Rock Creek north of the plant site (Figure E7-6). Lindsay Pond is about 200 m downstream (east) of SW005 and is an old farm pond (impoundment). SW0D1 is also a farm pond but is located southeast of the plant site in the Smart Ditch Creek drainage. Smart Ditch Creek and Rock Creek are not hydrologically connected to Woman Creek or Walnut Creek.

Samples were collected according to standard operating procedures for the collection of surface water at Rocky Flats (OPS SW.03). Stream samples were collected on August 1, 1991. Pond samples were collected on October 24, 1991. Sample containers were one-gallon plastic jugs provided by the laboratory. Samples were delivered to the laboratory on the same day that they were collected.

Toxicity tests were performed by T.H.E. Laboratory (now Seacrest Laboratory). Tests were started within 12 hours of sampling. Acute toxicity screens were conducted using whole (i.e., undiluted) samples from each site. Tests were conducted for the water flea (*Ceriodaphnia* sp.)

and the fathead minnow (*Pimphales promelas*) according to methods described in Peltier and Weber (1985)(see Attachment E-4 for methods). A total of 20 animals were tested in 4 separate containers (5 to a container). *Ceriodaphnia* tests were conducted for 48 hours, while the fathead minnow tests were run for 96 hours. Organisms were counted, and water was replaced in each container after each 24-hour period (static renewal). Results are reported as the total number of animals surviving at the end of the test. Control tests were run in parallel with each test.

E7.2.3 Statistical Analyses

For most of the investigations conducted as part of the OU1 EE, the data dictated reliance on a descriptive approach. Only some terrestrial vegetation data were subjected to statistical comparisons to determine the degree of differences between the OU1 study area and an uncontaminated reference area. Descriptive statistics (mean and standard deviation) were calculated for the vegetation measurement endpoints of basal cover, richness, diversity, production, and woody species density by habitat type and area (OU1 versus Rock Creek). As described previously, the Shannon-Weaver diversity index, which incorporates species richness and evenness, was calculated from basal cover data using the formula

Eq. E7-1

$$H' = \Sigma\ [(n_i/n) * 1n(n_i/n)]$$

where n_i is the number of individuals belonging to the ith species and n is the total number of individuals in the sample (Ludwig and Reynolds, 1988).

Statistical comparisons of vegetation community data for OU1 and the reference area were performed only for the mesic and xeric grassland habitats. Comparisons were made using a two-sample t-test for unequal variances. Marshland and riparian woodland habitats were present in both the study area and the reference area, but poor comparability and the potential for impacts from contamination associated with other operable units within the Woman Creek drainage would make it impossible to interpret any differences. Statistical comparisons for reclaimed grassland and disturbed land were not possible because these two types did not occur in the reference area. Summary statistics were prepared for all of these habitats to assist in site descriptions and qualitative evaluations.

Statistical comparisons between OU1 and the reference area were not performed using community data for small mammals or arthropods because of small sample sizes. Statistical comparisons with the reference area were also not used for assessing aquatic habitats because of poor comparability between Rock Creek and Woman Creek and between Lindsay Pond and Ponds C-1 and C-2. Poor comparability of the creeks was due to differences in flow regime, substrate, and composition of the adjacent riparian (perifluvial) community. The poor comparability of Lindsay Pond on Rock Creek with Ponds C-1 and C-2 on Woman Creek was the result of marked differences in age and history of use. For benthic macroinvertebrates, stream quality was compared for stations upstream and downstream of OU1.

Statistical comparisons with the reference area were also not used for assessing tissue concentrations of OU-specific contaminants or results of toxicity testing of OU1 surface water and sediment on standard test organisms. Evaluations of tissue data were limited to comparisons with published or calculated risk levels for biotic receptors. Toxicity testing of OU1 surface water and sediment was compared with results for an uncontaminated location on Woman Creek upstream of any IHSSs at RFP.

E7.3 RESULTS

E7.3.1 Ecological Investigations

The following subsections describe the results of quantitative ecological investigations of selected terrestrial and aquatic communities. Quantitative comparisons with the Rock Creek reference area are described for vegetation, small mammals, and terrestrial arthropods. Statistical analysis of these comparisons are presented for the mesic and xeric grassland communities.

E7.3.1.1 Vegetation

Data for mesic and xeric grassland sites in the study and reference areas were compared statistically using t-tests. Results of these statistical analyses, as well as descriptive statistics (means and standard deviations) for the measured endpoints of basal cover, richness, diversity, production, and woody species densities, are presented in Table E7-3. Tables E7-4 and E7-5 compare community composition characteristics for the mesic and xeric grassland communities. Endpoint values for the four remaining plant communities are summarized in Table E7-6. Tables E7-7 and E7-8 present basal cover and production values by life form and community type.

Section E2.2.1 provides detailed descriptions of the study area plant communities. Tables E2-1 and E2-2 summarize cover and production data for the study area communities. Detailed data for the study and reference area are included in Attachment E-2. Results for each community type are presented below.

<u>Mesic Grassland</u>

The mesic grassland community in OU1 was generally similar to that in the reference area. Basal cover was significantly lower in the study area than in the reference area (Table E7-3). Production was slightly higher in the study area, but the difference was not statistically significant. Species richness and diversity data for the two areas were essentially identical. Densities of trees, shrubs, and yucca were higher in the reference area, but not significantly so. Densities of cacti in the reference area were significantly higher.

The lower total cover in the study area (29 versus 37.0 percent) was due primarily to lower cover by grasses and cacti. Based on estimates of basal cover, the dominant species in both areas were western wheatgrass and blue grama. These native grasses had a combined cover of 14 percent in the study area, compared with 19.8 in the reference area. Total cover was nearly identical for native species in the study and reference areas: 76 and 74 percent, respectively. Contribution to total cover by perennials was greater in the study area (86 percent) than in the reference area (74 percent). This difference was due primarily to an abundance of Japanese brome, an exotic annual grass, in the reference area (Table E7-4).

Xeric Grassland

Results for xeric grassland reflect the generally poor quality of the study area. Cover, richness, diversity, and cacti density were all significantly lower in the study area. No trees, shrubs, or yucca were present along the transects in the study area, but the number in the reference area was so small that the difference was not statistically significant. Production was higher in the study area than in the reference area, but not significantly so. This higher value was due almost entirely to great mullein, a large, and robust, weedy, introduced species.

Grasses, forbs, and cacti cover values were all lower in the study area than in the reference area (a total of 19.6 versus 32.7 percent, respectively). Exposed rock contributed almost 25 percent of the total cover in the study site versus 8 percent in the reference area. Native species contributed 68 percent of the total basal cover in the study area, versus 80 percent in the reference area. Eighty-six percent of the total plant cover in the study area was attributed to perennial species versus 92 percent in the reference site (Table E7-5).

The dominant species in the study area was purple three-awn, a somewhat weedy native grass, with a cover of 12.1 percent. The second and thirdmost dominant plant species in the OU1 xeric grassland were introduced grasses: smooth brome, a perennial used to reclaim disturbed sites or improve range conditions, with a cover value of 29 percent; and cheatgrass, a highly invasive annual, with a cover value of 1.9 percent. Species dominance in the reference area was shared by five native perennial species: three grasses, a sedge, and an aster. This dominance pattern reflects the significantly higher mean diversity of the reference area (2.4) than that of the study area (1.1). Twice the number of native grass species (10.6 versus 5.0), and a large variety of forbs (30.8 versus 9.9), contributed to the higher species richness in the reference area.

Marshland

Physical differences between marshland in the study area (i.e., along the SID) and reference area (along a natural drainage) make it impossible to assess whether differences are due to OU-specific effects or ecological variability. However, as a qualitative assessment, the study area showed lower cover, richness, and diversity but higher production (Table E7-6).

The much higher cover in the reference area (38.0 versus 16.3 percent) was due primarily to an abundance of baltic rush and two weedy species, winter cress and Canada thistle. The higher production in the study area was a result of a very large contribution by both broadleaf and narrowleaf cattails.

Riparian Complex

As with marshland, poor habitat comparability between the study area and reference area make it inappropriate to compare the data statistically. Qualitatively, however, the riparian complex along Woman Creek in the study area had lower cover, richness, diversity, and cacti density but higher production than the analogous habitat in the Rock Creek reference area. Although both areas had essentially the same complement of tree and shrub species, their densities in the study area were twice as high as in the reference area (236.8 versus 473.8, respectively.)

The lower cover in the study area (21.6 versus 27.7 percent) was mostly the result of lower cover by graminoids and was not attributable to differences for one or a few species. Contribution to total cover by perennials was somewhat greater in the study area (92 versus 81 percent), but contribution by natives was lower (43 versus 55 percent). This reflects the greater abundance of quackgrass and smooth brome, two non-native perennial species, in the Woman Creek riparian zone. Shrub canopy cover was similar in the two areas (43.8 percent for Woman Creek, 47.1 percent for Rock Creek). The two dominant shrubs in both areas were leadplant and sandbar willow.

The higher production in the study area was due primarily to much greater biomass by graminoids, primarily cattails (Table E7-7). These large plants were not present in clipping plots in the Rock Creek riparian area.

Reclaimed Grassland

The reclaimed grassland community was ecologically notable due to the dominance of introduced perennial grasses, which prevented comparison within the reference area. However, quantitative comparisons of this community with other grassland types in the study area provide an ecological context for data presentation.

The low diversity value of 1.2 for the reclaimed grassland reflected the strong dominance by smooth brome, an introduced pasture grass, in this community. Smooth brome contributed 47 percent of the total cover in this grassland and was recorded along 90 percent of all cover transects. Another non-native perennial, intermediate wheatgrass, was the secondmost dominant plant, providing 12 percent of the total cover. Two native grasses, little bluestem and western wheatgrass, and an introduced species, crested wheatgrass, contributed 9, 6, and 5 percent, respectively, to the total cover. A species-poor, and sparse, forb component contributed only 7 percent of the total cover in this community.

Three parameters in the reclaimed grassland were similar in value to the same endpoints for the study area xeric grassland community. Both communities had low total basal cover (19.8 percent on the reclaimed area, 19.6 percent on the xeric site), species richness (22.9 and 23), woody plant densities (1.9 on both sites for trees, shrubs, and yucca), and cactus density (0.3 and 0.0).

Production in the reclaimed grassland (191.4 g/m^2) was higher than any other OU1 or reference area grassland community. This may be attributed to the dominance by non-native grasses, which contributed 92 percent of total production. This is not unexpected, because grasses used in reclamation, such as smooth brome and intermediate wheatgrass, are selected and bred for high productivity.

Disturbed Land

As with the reclaimed grassland community, disturbed land in the study site was not paired with a reference site. This community was notable for the dominance of weedy forbs, the presence of few native species, and large areas of bare soil.

The disturbed land community had the lowest total basal cover value of all community types (reference or study sites)(15.1 percent) and the largest amount of exposed soil (30.9 percent) (Table E2-2 and Table E7-8). Species richness averaged 23.3 and was composed primarily of non-native annuals or biennials. The diversity value of 1.6 reflects the even distribution of the dominant species. Smooth brome contributed 24 percent of the total cover and was found along all of the transects. The second and thirdmost abundant species were both introduced, weedy, annual grasses: cheatgrass and Japanese brome. Cheatgrass accounted for 21 percent of the total cover and was recorded on 67 percent of the transects. Japanese brome contributed 16 percent of the total cover and was found on 73 percent of the transects.

Production in the disturbed areas was relatively low (139 g/m^2). The dominant species, smooth brome, contributed 60 percent of total production. Twenty-eight percent of the total in this community was from all forbs combined. Densities of woody plants and cacti in this community (4.3 and 0.1, respectively) were low, which probably reflects the physical disturbance that has occurred in this area.

E7.3.1.2 Small Mammals

Small mammal data for the four selected habitat types showed some similarities and some substantial differences between the study area and reference area (see Tables E7-9 and E7-10). Both areas had a richness of four species for habitats and seasons combined and showed a general dominance of deer mice, with meadow voles being the second most abundant species overall.

Total small mammal captures were generally higher in the reference area. Using the data from the spring and fall live-trapping programs, comparisons of total captures for 100 trap-nights for the study area with the reference area are as follows: mesic grassland—5.7 vs. 7.3, 9.5 vs. 20.3; xeric grassland—0.0 vs. 6.0, 1.0 vs. 15.0; marshland—39.3 vs. 11.3, 30.8 vs. 41.3; and riparian woodland—15.3 vs. 36.3, 24.4 vs. 42.7. As noted previously, poor habitat comparability for the last two types limits the ability to draw inferences from the data. It is notable that mesic grassland and xeric grassland were the two least productive habitat types in both areas, although the reference area had both higher values and less disparity compared to the marshland and riparian woodland types.

Total captures for 100 trap-nights were 20.9 in spring and 16.8 in fall in the reclaimed grassland, and 32.5 in spring and 56.0 in fall in disturbed land. Of particular note is the capture of a Preble's meadow jumping mouse in the reclaimed habitat in spring. Although reclaimed and disturbed habitats have no reference sites for comparison, they had high capture rates. Small mammals are known to be abundant in areas with large numbers of seeds as are produced by the weedy annuals and introduced perennial grasses in reclaimed and disturbed habitats.

The small mammal data, while not amenable to rigorous statistical analysis, suggest that habitats in the OU1 study area, other than reclaimed grassland and disturbed land, are of lower quality for these animals than the reference areas. This result is consistent with the generally weedier, sparser, and/or more depauperate nature of study area habitats described above for plants and the lower numbers of terrestrial arthropods collected (see below). As discussed elsewhere, lower habitat quality in the study area is consistent with apparent previous disturbance.

E7.3.1.3 Terrestrial Arthropods

As shown by the sweep-netting data in Table E7-11, taxon richness (number of orders and families per transect) and abundance (number of individuals per transect) were almost always lower in the study area than the reference area. This pattern may reflect the generally lower cover, richness, and diversity values for vegetation in OU1. This could indicate that plant biomass, which was generally higher in the study area, is not as important an influence on the invertebrate community. It also is possible that whatever conditions led to the lower cover and richness in the study area had a direct and independent influence on the invertebrate community.

The smaller areal extent of study area habitats than similar reference area habitats may be an additional factor.

In both the study area and reference area, the most abundant arthropods were leafhoppers (Homopthera: Cicadellidae). These herbivorous insects comprised 25 percent of the total in OU1 and 35 percent in the reference area. Combined homopterans (including cicadas, aphids, and allies as well as leafhoppers) provided 33 and 44 percent of total arthropods captured in the study area and reference area, respectively. Relative abundance (percent of total captures) by other prevalent arthropod groups, expressed as study area versus reference area, is as follows: Araneae (true spiders)—9.6 vs. 9.6; Orthoptera (grasshoppers, crickets, mantids, and allies)—15.1 vs. 5.6; Hemiptera (true bugs)—13.0 vs. 9.0; Hymenoptera (ants, bees, wasps, and allies)—9.8 vs. 18.2; Coleoptera (beetles)—9.0 vs. 5.8; and Diptera (flies)—7.6 vs. 5.3. Dominant families within each of these higher taxonomic levels were the same in the study area and reference area (see Section E2.2.2.2 and Table E2-4).

E7.3.1.4 Benthic Macroinvertebrates

In general, the benthic community in downstream sites (WORI1 and WORI3) was more developed and diverse than in upstream sites (SW039 and SW033). Similar trends were demonstrated in data for spring and fall sampling. Data are presented in Table E7-12 for spring sampling. Raw data are presented in Attachment E-2. This condition is consistent with natural changes in stream communities as stream size increases with distance from the headwaters (Ohio EPA, 1988). The results do not appear to be consistent with an adverse impact from OU1 contaminant sources.

For the spring sampling event, taxon richness was significantly higher for downstream sites than upstream sites (Table E7-12). The FBI indicated an approximately equal proportion of tolerant species in both areas. Feeding guild analysis showed no clear trends in community composition (Table E7-12). These results may be more indicative of flow and incident light conditions than of substrate or water quality. All four sites sampled were riffle communities, but bank vegetation varied among the sites and may have lead to variable amounts of sunlight available for periphyton growth. No clear trends were apparent in the EPT:chironomid ratio. The abundance of chironomids was greater than EPT at all sites except WORI3, but the ratio varied considerably (Table E7-12). Chironomidae was the dominant family at each of the sites but comprised 80 percent of the total individuals at SW033. WORI1 and WORI3 contained more EPT than the upstream sites and may be a reflection of greater flow. Community similarity was never greater than 25 percent between any two sites (Table E7-12). This comparison is consistent with the lack of clear trends in the other metrics applied to stream benthos data.

Similar trends were demonstrated in fall data. Species richness was approximately equal for upstream and downstream sites. Upstream sites contained slightly higher ratios of tolerant species. The ratio of scrapers to filterers plus collectors was 212:532 for upstream sites combined and 90:92 for downstream sites combined. EPT individuals outnumbered chironomids at all sites except WORI1 (Table E7-12). EPT taxa (primarily caenid mayflies) strongly dominated the benthic community at SW033. The farthest downstream site, WORI1, exhibited the greatest taxon diversity, while the most upstream site, SW039, had the lowest diversity. Surface water station SW033 contained the greatest number of EPT taxa (10); on average, however, downstream sites displayed greater richness for this parameter.

Surface impoundment data were not evaluated using the RBP III, because this methodology was developed specifically for lotic (stream and river) systems. The benthic communities of Pond C-1 and Pond C-2 were comprised almost exclusively of oligochaetes (earthworms) and dipterans (especially Chironomidae). These invertebrate groups are generally very tolerant of high turbidity, fine substrate, and low dissolved oxygen associated with ponds. However, pollution sensitive insects also were present in low numbers. These included caenid mayflies in Pond C-1 and water boatmen (Hemiptera: Corixidae) in Pond C-2. Since a suitable reference area for the two ponds was not identified, these data should be treated as a qualitative assessment only.

E7.3.1.5 Fishes

Because of poor habitat comparability and differences in management history of Woman Creek and Rock Creek, it was decided that statistical comparisons would be inappropriate. Differences in fish communities between upstream and downstream stations on Woman Creek within the study area (see Section E7.1.2 and Table E2-6) were also of limited utility in assessing ecological impacts, because differences in water quality, physical habitat quality, and persistence of flow probably would mask any potential contaminant effects. Indeed, the downstream station (WORI1) yielded more species of fish than the two upstream sites, probably because of greater flows.

E7.3.1.6 Results of Aquatic Toxicity Screening

Aquatic toxicity screens were conducted at the sites identified in Section E7.2. Screens were conducted using fathead minnows and *Ceriodaphnia* and unfiltered surface water collected at designated sites. Survivorship of fathead minnows was at least 90 percent of controls in 11 of 13 tests (Table E7-13; see Attachment E-4) including all sites directly downgradient or adjacent to OU1. The lowest survivorship was observed for samples from SW005 and SW104. Both of these sites are outside the impact of the OU1 area, and the source of toxicity, while unknown, is not associated with OU1.

Survivorship of *Ceriodaphnia* was below 80 percent at all stream sites upstream of Pond C-2, including sites upgradient of OU1 and outside any apparent impact of the industrial area of RFP (Figure E7-6). Stations upstream of OU1 showed equal or greater toxicity to test organisms. Therefore, the source of toxicity cannot be isolated to OU1 IHSSs. In fact, toxicity was slightly less in the OU1 area. Since OU1 did not seem to introduce additional toxicity to Woman Creek waters, no further toxicity testing was performed.

Table E7-1

Selection Criteria for OU1 Terrestrial Study and Reference Sites for Ecological Studies

Site Type/ Descriptor	Selection Criteria				
	Habitat Type(s)	Sample Unit	Aspect	Slope (Degrees)	Soil Type
Wetland/Marshland					
BA01A	020/030	Linear	E	<5	31
BA01R	020/030	Linear	E	<5	31/100
MA01A	010	Linear	S	5-10	31
MA02A	020/030	Linear	ENE	<5	31
MA03A	020/030	Linear	ENE	<5	31
MA04A	010/020/030	Grid	SSE	<5	60
MA01R	010/020/030	Linear	NE	<5	60
MA02R	020/030	Grid	NW	<5	31
MA03R	010/020/030	Linear	E	<5	31
MA04R	020/030	Grid	NW	5-10	31
Mesic Grassland					
BG01A	322	Linear	SE	10-30	31
BG02A	322	Linear	SE	5-25	31
BG03A	322	Linear	S	5-20	31
BG01R	322	Linear	SE	5-30	31
MG01A	322	Grid	S	5-20	31
MG02A	322	Grid	S	5-20	31
MG03A	322	Grid	SE	10-20	31
MG04A	322	Grid	SE	10-20	31/100
MG01R	322	Grid	SE	10-25	31
MG02R	322	Grid	SE	10-30	31
MG03R	322	Grid	SSE	20-30	31
MG04R	322	Grid	SE	10-30	31
Xeric Grassland					
BX01A	323	Linear	SE	<5	31
BX01R	323	Linear	E	<5	45
BX02R	323	Linear	E	<5	31
MX01A	323	Linear	E	<5	31
MX01R	323	Grid	E	<5	46
MX02R	323	Grid	E	<5	45
MX03R	323	Grid	E	<5	31/45/100
MX04R	323	Grid	E	<5	45
Disturbed					
DB01A	410/420	Linear	SE	5-15	31
MD01A	410/420	Linear	SE	5-15	31
MD02A	410/420	Linear	SE	5-15	31

Table E7-1
(Continued)

Selection Criteria for OU1 Terrestrial Study and Reference Sites for Ecological Studies

Site Type/ Descriptor	Selection Criteria				
	Habitat Type(s)	Sample Unit	Aspect	Slope (Degrees)	Soil Type
Woodland					
BW01A	110/210/220	Linear	E	<5	60
BW01R	110/210/220	Linear	NE	<5	60
MW01A	110/210	Grid	S	<5	31
MW02A	110/210/220	Grid	E	<5	60
MW03A	110/210	Linear	E	<5	60
MW04A	110/210/220	Grid	E	<5	60
MW01R	110/210/220	Linear	E	<5	31
MW02R	110/210/220	Linear	NE	<5	60
MW03R	110/210/220	Linear	NE	<5	60
MW04R	110/210/220	Linear	NE	<5	60
Reclamation					
BR01A	324	Linear	SE	10-15	100/45
BR02A	324	Linear	SE	10-15	100/45
BR03A	324	Linear	S	5-10	31/60
BR04A	324	Linear	S	5-20	31
MR01A	324	Grid	SE	<5	31
MR02A	324	Grid	SE	<5	60
MR03A	324	Grid	SE	10-25	100/45
MR04A	324	Grid	SE	10-25	100/45

Habitat Codes:	10	Wet Meadow Ecotone
	20	Short Marsh
	30	Tall Marsh
	110	Deciduous Woodland
	210	Riparian Shrubland
	220	Short Shrub
	322	Mesic Mixed Grassland
	323	Xeric Mixed Grassland
	324	Rehabilitation Grassland
	410	Disturbed/Bare Ground
	420	Disturbed/Annual Weed Complex
Soil Types:	31	Denver/Kutch/Midway
	45	Flatirons Cobbly
	46	Flatirons Stony
	60	Haverson
	100	Nederlands

Table E7-2

Summary of Physical Features: Woman Creek Study Sites and Rock Creek Reference Sites
Operable Unit No. 1 Environmental Evaluation
Rocky Flats Plant

Riffle Sites

Criterion	OU1 Study Sites on Woman Creek								Rock Creek Sites		
	WORI2	SW107	SW039	SW033	SW032	WORI3	WORI1	SW026	RCRI1	RCRI2	RCRI3
Flow (cfs)[a]	0.1/0.3	<0.25/0.6	0.3/0.8	0.25/1	0.5/1	0.5/1	0.5/1	<0.25	0/0.3	0.1/0.5	0.1/0.5
Depth (cm)	5-10	10	7-13	10	5-9	7-13	10	5-10	7-15	7-10	5-15
Current Velocity (m/s)[b]	0.3-0.6	0.3-0.6	0.6-0.9	0.3-0.6	0.3-0.6	0.3-0.6	0.3-0.6	0.6-0.9	0.5	0.6-0.9	0.3
Substrate	gravel/ cobbles	gravel	gravel/ cobbles	gravel/ cobbles	gravel/ cobbles [c]	sand/ cobbles	cobbles	cobbles	gravel/ cobbles	gravel/ cobbles	sand/ cobbles
Shade	no[d]	yes[e]	yes[e]	yes[e]	yes[e]	yes[e]	yes[e]	yes[e]	yes[e]	no[d]	yes[e]

[a]Low flow during late summer/base flow during spring and early summer; visually estimated using cross-section, current velocity, and depth

[b]Visually estimated

[c]Heavy siltation occurred between spring and fall sampling, apparently from road grading activity upstream from SW034

[d]Stream banks predominantly herbaceous (grass) cover, little shade

[e]Stream banks with dense stands of willows, >75% shaded during July-September

Table E7-2
(Continued)

Summary of Physical Features: Woman Creek Study Sites and Rock Creek Reference Sites
Operable Unit No. 1 Environmental Evaluation
Rocky Flats Plant

Pool Sites

Criterion	Woman Creek Sites		Rock Creek Sites			
	WOPO1	WOPO2	RCPO1	RCPO2	RCPO3	RCPO4
Flow (cfs)	NE	NE	NE	NE	NE	NE
Depth (cm)[a]	41	42	30[b]	50	25[b]	15[b]
Current Velocity (m/s)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Substrate	fine sand/ cobbles	sand/silt	silt/sand	sand/ gravel	sand/ cobbles	sand
Shade	yes[c]	yes[c]	no[d]	no[d]	no[d]	no[d]

[a]Deepest location sampled
[b]Estimated
[c]Shaded by tree canopy (>0.3 m high), some willows on bank
[d]Stream banks predominantly herbaceous (grass) cover, little shade
NE = not estimated

Pond Sites

Criterion	Woman Creek Sites		Rock Creek
	C-1	C-2[a]	Lindsay Pond
Maximum Depth (m)	1.2	4.6	1.4
Bank Vegetation	willows/cattails	cattails/rushes	cattails/sedges/rushes

[a]Pond C-2 is fed by the South Interceptor Ditch, not Woman Creek; depth is highly variable due to scheduled releases

Table E7-3

Means (± standard deviation) and t-test Results for Basal Cover (%), Species Richness, Diversity, Production (g/m^2), and Woody Species Densities in Grassland Habitats in OU1 Study Area and Reference Area

Habitat Type	Study Area	Reference Area	Probability	Significance
Mesic Grassland				
Cover (n = 10)	29 ± 6.3	37.0 ± 5.0	0.0071	*
Richness (n = 10)	45 ± 4.9	44 ± 9.4	0.70	n.s.
Diversity (n = 10)	1.8 ± 0.4	1.7 ± 0.47	0.52	n.s.
Production (n = 30)	180 ± 108	170 ± 86	0.67	n.s.
Tree, Shrub, and Yucca Density (n = 10)	0	24 ± 62	0.078	n.s.
Cacti Density (n = 10)	8.5 ± 11	34 ± 29	0.017	*
Xeric Grassland				
Cover (n = 10)	20 ± 2.9	33 ± 3.3	5.9E-08	*
Richness (n = 10)	23 ± 2.4	51 ± 6.6	5.8-08	*
Diversity (n = 10)	1.1 ± 0.34	2.4 ± 0.29	4.3E-08	*
Production (n = 30)[a]	130 ± 92	123 ± 33	0.67	n.s.
Tree, Shrub, and Yucca Density (n = 10)	0	5.1 ± 15	0.17	n.s.
Cacti Density (n = 10)	0	80 ± 40	6.3E-05	*

[a] n = 20 in reference area
* Study and reference areas significantly different, $p < 0.05$
n.s. not significant

Table E7-4

Mean Basal Cover, Species Richness, and Production of Native and Introduced Grasses and Forbs in Grassland Habitats in OU1 Study Area and Reference Area[a]

	Mesic Grassland			Xeric Grassland		
	Cover (%)	Richness (# of species)	Production (g/m^2)	Cover (%)	Richness (# of species)	Production (g/m^2)
Study Area						
Grasses[b]	23.7	13.6	110.6	18.2	8.0	85.7
Native	19.1	9.8	96.2	12.5	5.0	25.2
Introduced	4.6	3.8	14.4	5.7	3.0	60.5
Forbs	4.9	30.1	69.0	1.5	14.9	43.9
Native	2.7	22.6	40.4	0.9	9.9	29.4
Introduced	2.2	7.5	28.6	0.6	5.0	14.5
Reference Area						
Grasses[b]	31.4	10.8	149.8	17.6	13.5	70.8
Native	23.6	7.7	96.0	15.4	10.6	60.0
Introduced	7.8	3.1	53.8	2.2	2.9	10.8
Forbs	4.4	30.6	19.4	9.3	34.1	50.3
Native	2.5	24.9	14.9	8.8	30.8	49.3
Introduced	1.9	5.7	4.5	0.5	3.3	1.0

[a] Values may differ from detailed data shown in Attachment E-2 because of rounding
[b] Cover values for grasses are the difference of total graminoid cover and total nongrass graminoid cover in Attachment E-2-1

Table E7-5

Mean Basal Cover, Species Richness, and Production of Annual/Biennial and Perennial Grasses and Forbs in Grassland Habitats in OU1 Study Area and Reference Area[a]

	Mesic Grassland			Xeric Grassland		
	Cover (%)	Richness (# of species)	Production (g/m^2)	Cover (%)	Richness (# of species)	Production (g/m^2)
Study Area						
Grasses						
Annual/ Biennial	1.9	2.2	3.8	1.9	1.1	2.6
Perennial	21.8	11.4	106.7	16.2	6.9	83.0
Forbs						
Annual/Biennial	2.0	14.3	30.9	0.9	9.8	40.6
Perennial	2.9	15.8	37.3	0.6	5.2	3.3
Reference Area						
Grasses						
Annual/Biennial	6.1	2.0	11.7	0.7	1.6	0.0
Perennial	25.3	8.8	138.1	20.6	11.9	70.8
Forbs						
Annual/Biennial	2.3	12.0	7.0	1.8	7.5	0.4
Perennial	2.2	18.3	12.4	7.5	26.6	50.0

[a] Values may differ from detailed data shown in Attachment B because of rounding

Table E7-6

OU1 Study Area and Reference Area Comparison Mean Basal Cover (%), Species Richness, Diversity, Production (g/m^2), and Woody Species Densities by Community Type[a]

Habitat Type	Study Area	Reference Area
Marshland		
Cover	16.3	38.0
Richness	18.2	35.1
Diversity[b]	0.9	1.7
Production	387.2	241.0
Tree, Shrub, and Yucca Density	5.7	30.7
Cacti Density	0	1.5
Riparian Complex		
Cover	21.6	27.7
Richness	51.0	61.9
Diversity[b]	1.7	2.3
Production	105.5	77.4
Tree, Shrub, and Yucca Density	454.5	236.8
Cacti Density	4.4	14.0
Reclaimed Grassland[c]		
Cover	19.8	---
Richness	22.9	---
Diversity[b]	1.2	---
Production	191.4	---
Tree, Shrub, and Yucca Density	1.9	---
Cacti Density	0.3	---
Disturbed Land[c]		
Cover	15.1	---
Richness	23.3	---
Diversity[b]	1.6	---
Production	139.5	---
Tree, Shrub, and Yucca Density	4.3	---
Cacti Density	0.1	---

[a] Refer to Table E7-1 for means and t-test results for mesic and xeric grassland
[b] n = 10, except for diversity in marshland, disturbed land, and riparian woodland study areas, where n = 15
[c] Community type does not occur in reference area

Table E7-7

Mean Plant Production (g/m²) by Life Form and Community Type in OU1 Study Area and Reference Area[a]

Life Form	Mesic Grassland	Xeric Grassland	Marshland	Riparian Woodland	Reclaimed Grassland[b]	Disturbed Land[b]
Study Area						
Sample Size	30	30	30	30	20	30
Graminoids	111	86	334	90	186	102
Forbs	69	44	54	16	5.4	38
Total	180	130	388	106	191	140
Reference Area						
Sample Size	30	30	30	30	---	---
Graminoids	150	71	153	50	---	---
Forbs	20	52	88	28	---	---
Total	170	123	241	78	---	---

[a]Values may differ from detailed data shown in Attachment B because of rounding
[b]Community type does not occur in reference area

Table E7-8

Mean Basal Cover (%) by Life Form and Community Type in OU1 Reference Area[a]

	HABITAT TYPE			
	Mesic Grassland	Xeric Grassland	Marshland	Riparian Woodland
Sample Size	10	10	10	10
Life Form				
Graminoids	31	21	28	21
Forbs	4.5	9.3	10	4.5
Trees and Shrubs	0	0	0.1	1.5
Cacti	1.1	2.1	0	0.6
Total Plant Cover	37	32	38	28
Rock	2.2	8.2	0.3	17
Bare Soil	3.0	4	0.8	5.1
Litter	58	55	61	50

[a]Values may differ from detailed data shown in Attachment B because of rounding

Table E7-9

Relative Abundance and Percent Dominance (in Parentheses) of Small Mammals in OU1 Study Area and Reference Area, Spring 1991[a]

SPECIES[b]	MIOC	MIPE	PEHI	PEMA	REMO	ZAHU	ZAPR	NEME	TOTAL
Study Area									
Mesic Grassland	0	1.7 (30%)	0	3.3 (57%)	0.7 (13%)	0	0	0	5.7
Xeric Grassland	0	0	0	0	0	0	0	0	0
Marshland	0	15.0 (38%)	0.3 (0%)	23.5 (60%)	0.5 (1%)	0	0	0	39.3
Riparian Woodland	0	4.0 (26%)	0	11.3 (74%)	0	0	0	0	15.3
Reclaimed Grassland	0	9.3 (44%)	0	11.3 (54%)	0	0.3 (1%)	0	0	20.9
Disturbed Land	0.5 (1%)	2.5 (8%)	1.0 (3%)	28.5 (88%)	0	0	0	0	32.5
Reference Area									
Mesic Grassland	0	2.3 (31%)	0	5.0 (69%)	0	0	0	0	7.3
Xeric Grassland	1.3 (21%)	0	0	4.7 (79%)	0	0	0	0	6.0
Marshland	0	9.3 (82%)	0	2.0 (18%)	0	0	0	0	11.3
Riparian Woodland	0	12.5 (34%)	0	22.3 (61%)	0	0	1.5 (21%)	0	36.3

[a] Relative abundance = number caught per 100 trap nights
Dominance = percent of total captured

[b] MIOC = *Microtus ochrogaster*
MIPE = *Microtus pennsylvanicus*
PEHI = *Perognathus hispidus*
PEMA = *Peromyscus maniculatus*
REMO = *Reithrodontomys montanus*
ZAHU = *Zapus hudsonius*
ZAPR = *Zapus princeps*
NEME = *Neotoma mexicana*

Table E7-10

Relative Abundance and Percent Dominance (in Parentheses) of Small Mammals in OU 1 Study Area and Reference Area, Fall 1991[a]

SPECIES[b]	MIOC	MIPE	PEHI	PEMA	REMO	ZAHU	ZAPR	NEME	TOTAL
Study Area									
Mesic Grassland	0	3.7 (39%)	0.3 (3%)	5.5 (58%)	0	0	0	0	9.5
Xeric Grassland	0	0	0	0	1.0 (100%)	0	0	0	1.0
Marshland	0	15.3 (50%)	0.5 (1%)	15.0 (49%)	0	0	0	0	30.8
Riparian Woodland	0	10.7 (44%)	1.0 (4%)	12.7 (52%)	0	0	0	0	24.4
Reclaimed Grassland	0.3 (1%)	6.7 (40%)	0.5 (3%)	9.3 (56%)	0	0	0	0	16.75
Disturbed Land	0	13.5 (24%)	0.5 (1%)	41.5 (74%)	0	0	0	0.5 (1%)	56.0
Reference Area									
Mesic Grassland	0.3 (1%)	1.0 (5%)	0	19.0 (94%)	0	0	0	0	20.3
Xeric Grassland	0.3 (2%)	3.7 (10%)	0	11.0 (88%)	0	0	0	0	15.0
Marshland	0	26.0 (63%)	0	15.3 (37%)	0	0	0	0	41.3
Riparian Woodland	0	8.0 (19%)	0	34.7 (81%)	0	0	0	0	42.7

[a] Relative abundance = number caught per 100 trap nights
Dominance = percent of total captured

[b] MIOC = *Microtus ochrogaster*
MIPE = *Microtus pennsylvanicus*
PEHI = *Perognathus hispidus*
PEMA = *Peromyscus maniculatus*
REMO = *Reithrodontomys montanus*
ZAHU = *Zapus hudsonius*
ZAPR = *Zapus princeps*
NEME = *Neotoma mexicana*

Table E7-11

Number of Taxa and Individuals of Terrestrial Arthropods by Habitat Type in OU1 Study Area and Reference Area[a]

Habitat Type	Study Area	Reference Area
Mesic Grassland		
Orders	10	8
Families	46	39
Individuals	583	875
Xeric Grassland		
Orders	8	8
Families	23	45
Individuals	106	736
Marshland		
Orders	12	13
Families	65	73
Individuals	670	1,064
Riparian Woodland		
Orders	14	16
Families	65	78
Individuals	1,111	2,184
Reclaimed Grassland[b]		
Orders	10	---
Families	50	---
Individuals	527	---
Disturbed Land[b]		
Orders	9	---
Families	37	---
Individuals	434	---

[a] Sweep-netting only
[b] Habitat type does not occur in reference area

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Table E7-12

Comparision of Benthic Macroinvertebrate Community Metrics[a]

Metric	Sampling Site and Date Sampled SW039 6/17/91	SW033 6/14/91	WORI3 6/13/91	WORI1 6/12/91
Taxa Richness	18	18	29	25
Family Biotic Index (modified)	5.55	5.83	5.80	5.32
Scrapers/Filterers + Collectors	43/208	32/16	28/40	5/171
EPT/Chironomidae	167/304	96/510	178/39	267/304
% Contribution of Dominant Family	43%	80%	27%	43%
EPT Index	4	7	11	10

Jaccard Similarity Index

	SW033	SW039	WORI1	WORI3
SW033	--	0.20	0.20	0.20
SW039	0.20	--	0.20	0.18
WORI1	0.20	0.20	--	0.22
WORI3	0.20	0.18	0.22	--

[a]EPA, 1989

Table E7-13

Results of Aquatic Toxicity Screens in Woman Creek -- 1991

Sample Site	Ceriodaphnia[a]			Fathead Minnows[b]		
	Test Water[c]	Control[c]	% Control[d]	Test Water[c]	Control[c]	% Control[d]
Stream Sites						
SW005	5	18	28%	16	20	80%
SW104	11	18	61%	10	20	50%
SW041	7	18	39%	20	20	100%
SW039	10	18	56%	18	20	90%
SW033	5	18	28%	18	20	90%
SW032	10	18	56%	20	20	100%
WORI3	11	18	61%	19	20	95%
WORI1	15	18	83%	19	20	95%
WOPO2	17	18	94%	19	20	95%
Pond Sites						
Lindsay Pond	19	18	106%	19	19	100%
SW0C1	20	18	111%	20	19	105%
SW0C2	19	18	106%	20	19	105%
SW0D1	19	18	106%	20	19	105%

[a]48-hour acute toxicity screen with undiluted water from each site

[b]96-hour acute toxicity screen with undiluted water from each site

[c]Results are number of survivors out of 20

[d]Result from Test divided by results from Control

SECTION E8
UNCERTAINTY

This section is intended to summarize the sources and potential effects of uncertainty on the OU1 EE. The three general sources and the approach to incorporating them into this risk assessment are discussed below. Specific sources and effects of uncertainty in the OU1 EE are discussed in Section E8.2 and summarized in Table E8-1. Discussions of the sources and potential effects of uncertainty also are presented with descriptions of specific methods and approaches. A detailed discussion of the sources of uncertainty for the Toxicity Assessment is presented in Section E5.1.1.

E8.1 GENERAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENTS

Many sources of uncertainty are associated with ecological risk assessments or other environmental investigations. The term "risk" itself implies uncertainty about the outcome of the process under study. Suter *et al.* (1987) identify three main categories of uncertainty sources:

- The fundamentally stochastic (random) nature of the environment
- Incomplete knowledge of the system under study
- Uncertainty associated with execution of the study

The stochastic variability of nature can be quantified and characterized but not reduced, because it is a fundamental property of the system. Some aspects of ecological systems are predictable at some level but the components that are amenable to measurement often have a significant amount of random variability associated with them. Variability within a data set can be reduced by narrowing the scope of sampling to include items of similar qualities, such as collecting only female mice of a certain age and weight. However, the general applicability of the results is proportionately narrowed.

The second source of uncertainty refers to scientific ignorance of the system under study. This source is theoretically reducible, but only at the considerable cost of exhaustive sampling or experimental manipulation. The goal of the RFI/RI and associated risk assessments is not to eliminate uncertainty. Rather, the uncertainty should be characterized in a way that allows it to be used in making informed risk management decisions (EPA, 1988a). This type of uncertainty has traditionally been countered by application of conservative assumptions about exposure parameters. However, this practice can lead to inconsistent estimation of risk, take accurate estimates of uncertainty out of the decision process, and generate "false positives" that may lead to unnecessary, costly, and possibly damaging remedial actions (Paustenbauch, 1990).

The third source of uncertainty involves execution of data collection and analysis. This source of uncertainty includes inappropriate sampling locations, inaccurate or inconsistent sample collection methods, and data recording errors. This type of uncertainty should be addressed in quality assurance plans and site audits. Sampling for the OU1 EE was performed in accordance with standard operating procedures for collection of ecological data at the RFP (EG&G, 1991), and field audits were conducted by independent EG&G and DOE contractors. Their reports are available from DOE and EG&G.

E8.2 SPECIFIC SOURCES OF UNCERTAINTY IN THE OU1 EE

E8.2.1 Data Collection and Analysis

E8.2.1.1 Variability in Site Data

The variability observed in data collected from OU1 is due to a combination of natural variation and imprecision in sampling design, execution of sampling methods, and laboratory analysis. As noted above, stochastic variability of nature is unavoidable. Variability due to sampling can be reduced by close adherence to quality assurance/quality control (QA/QC) requirements and precise sampling and analysis techniques. However, it is impractical to attempt quantitative estimation of the contribution from different sources in the scope of an ecological risk assessment.

The variability of within-site data was quantified where possible by collection of multiple samples and calculation of means and standard deviations for the resulting data sets. These values are presented with results in tables and figures where appropriate. Where possible, variability in population or community data was quantitatively considered by using statistical comparison with similar data from the reference area. This is a standard approach for including variation in natural ecosystems in quantitative assessment of ecological impact (EPA, 1989b).

Variability in the chemical data also was used to quantify uncertainty in exposure estimations by substituting the statistical distributions of contaminant concentrations into otherwise deterministic models used to integrate exposures across time and space. Distributions were iteratively "sampled" using the Latin hypercube procedure and the resulting parameter values used in exposure calculations (Bartell *et al.*, 1992; Iman and Conover, 1980, 1981) (see Section E6.1.4). Through this method, uncertainty (variability) in the exposure point concentrations was propagated through the calculations and included in the exposure estimates (Kirchner, 1993). Quantitative expressions of uncertainty are included in the result and assigned probabilities for exceeding predetermined critical concentrations or estimated exposures.

E8.2.1.2 Sample Collection and Analysis

Another source of uncertainty in the data collection was the initial sampling design including siting of sampling locations and selection of sampling and analysis methods. The abiotic investigations for the OU1 Phase III RFI/RI were not necessarily designed with the objectives of the EE in mind. Therefore, the data produced were not specifically collected for the purpose of estimating exposure of ecological receptors to COCs. However, the data are viewed as adequate for the screening level approach necessary because contaminants were not known prior to collection of the abiotic data.

Abiotic investigations planned for OU1 were reviewed to determine acceptability for purposes of evaluating ecotoxicity in potentially contaminated areas. In general, sampling of soil and groundwater was concentrated in and around IHSSs and downgradient areas causing these areas to be over-represented in the resulting data set. Thus, exposures calculated from site-wide data probably overestimated the actual exposures encountered by wide-ranging organisms using all parts of OU1 equally.

The depth of soil and groundwater sampling also was adequate for this evaluation. Surficial soil samples were taken from the upper 5 cm. Other samples were collected by compositing soils over 60-cm to 1.5-m depth intervals to a maximum depth of approximately 6 m. Groundwater was characterized over the entire depth profile, and water level measurements from monitoring wells provided data on the minimum and maximum depths to groundwater during the year. This sampling was not specifically designed to provide data on potential phytotoxicity in the rooting zone or exposure of burrowing animals to contaminants. However, it is adequate to assess areas of contaminated soil or groundwater that contain contaminants at concentrations that may be toxic to plants or fossorial animals.

Methods for analysis of abiotic samples were also a potential source of uncertainty because they were not selected to assess the fraction of the contaminant that was bioavailable. This was a source of uncertainty for the exposure assessment and is discussed below in Section E8.2.3.

In some cases uncertainty was introduced by lack of data on chemical concentrations at specific exposure points. For example, data on PCB and PAH content of biological tissues was not collected because the presence of these contaminants was not anticipated prior to EE field data collection. EE fieldwork was scheduled for completion before results of the abiotic investigation were available. Therefore, assumptions of uptake rate and biological half-life were made to estimate potential tissue concentrations in forage or prey species. These assumptions are likely to result in overestimates of the actual concentrations and, therefore, result in overestimates of site-specific exposures.

Aquatic toxicity screens were conducted in 1991 using surface water from various stations along Woman Creek. The purpose of the screen was to determine whether any gross toxicity was being introduced to Woman Creek from OU1 (see Section E7). This assessment was not intended to be a comprehensive evaluation of water quality and toxicity in the Woman Creek drainage. To this end aquatic toxicity *screens* were used. Comprehensive evaluation of Woman Creek will be conducted during the OU5 RFI/RI.

Results of toxicity screens indicate some toxicity of water at SW033 and WORI3 to *Ceriodaphnia*. However, greater toxicity was detected at reference sites indicating the potential for natural toxicity in the surface waters at Rocky Flats. Further investigation including full dilution series toxicity tests and toxicity identification evaluation (TIE) is needed to determine the causes and sources of toxicity in surface waters. No further toxicity tests were conducted for the OU1 EE because the screens did not indicate that toxicity was directly attributable to OU1 sources because other areas showed greater toxicity.

Evaluation of ecological impacts was also affected by selection of sampling locations. The reclaimed and disturbed grassland habitat types were well represented in the OU1 area, but adequate reference areas were not available for comparison. Thus, interpretation of ecological data with respect to contaminant concentrations required a search of background information on the structure of grass communities composed primarily of introduced species. See Section E7 and E9 for a detailed discussion of reclaimed and disturbed areas in OU1.

E8.2.2 COC Selection and Toxicity Assessment

The COC selection process was discussed in detail in Section E4. The list of chemicals considered for inclusion in the COCs was generated as a result of preliminary analysis of the "nature and extent" of contamination (see Appendix D of the Phase III RFI/RI Report). This process included statistical comparisons of abiotic data from OU1 to Rocky Flats background concentrations. The process also included use of professional judgement by geologists and geochemists to determine whether metals or radionuclides in soils or groundwater at OU1 were deposited there as a result of RFP activities or natural processes. As a result of this process the metals manganese and antimony were not identified as contaminants even though concentrations in individual soil and groundwater samples exceeded RFP background levels. Both of these metals are relatively abundant in the earth's crust and therefore occur in natural ecosystems. However, both metals also may be toxic to plants and animals if present at high enough concentrations.

E8.2.2.1 Manganese

Manganese is an essential nutrient of both plants and animals where it is a cofactor for enzymes involved in phosphorylation, fatty acid synthesis, energy transformation, and bone development

(Smith, 1990; Goyer, 1991). Because it is a nutrient, relatively robust physiological mechanisms exist for regulation of manganese concentrations in living organisms. Manganese has a relatively low toxicity to invertebrates and vertebrates (NAS, 1973; Ireland, 1979; Hartenstein *et al.*, 1981; Goyer, 1991) and is often excluded from risk assessments because it is an essential nutrient.

Manganese has been shown to be toxic to some domestic grains at levels from 80 to 5,000 mg/kg (Smith, 1990). Manganese concentrations in this range are often found in nature, and native plant species are physiologically acclimatized or evolutionarily adapted to growth at ambient manganese concentrations. Toxic conditions are usually associated with acidic soils and warm climates. Manganese deficiency is more common than manganese toxicity in neutral or alkaline soils such as those found at Rocky Flats. A concentration of 50 mg/kg dry weight in foliage is considered adequate for normal growth in most plant species (Salisbury and Ross, 1985).

Background concentration of manganese in surface soils at Rocky Flats is approximately 800 mg/kg; the background concentration in groundwater is 932 mg/L. The mean concentrations of manganese did not exceed background in any abiotic media at OU1. However, concentrations in subsurface soils and groundwater exceeded background at some subsurface soil and groundwater sampling locations (see Appendix D of Phase III RFI/RI Report). The maximum concentrations in subsurface soil (1,873 mg/kg) and groundwater (3,660 mg/L) were found in samples from colluvial material. While these concentrations are within the potentially phytotoxic range, the ecological risks posed by the isolated areas of elevated manganese appear to be minimal. Plant species adapted to soils of the Colorado Piedmont are likely to be tolerant of the ambient manganese concentrations at Rocky Flats. Groundwater concentrations could be toxic to individual plants if root contact was frequent or of long duration. However, elevated manganese does not pose a threat to plant populations and communities.

The threat of ecotoxicological effects from manganese in surface water also appears to be minimal. The mean total concentration (unfiltered) of manganese detected in surface water at OU1 was 52 mg/L with a maximum concentration of 621 mg/L. These concentrations are typical of background concentrations at Rocky Flats. The mean total concentration and 95 percent upper tolerance limit (UTL) at background sites was 45 and 687 mg/L, respectively. Dissolved (filtered) manganese is also similar to background. The mean and maximum concentrations in Woman Creek are 22 and 290 mg/L, respectively. The mean and UTL in background samples are 21 and 292 mg/L, respectively. The range of concentrations are within state standards for water quality in the Big Dry Creek basin. Colorado WQCC standards for manganese in Woman Creek are 560 mg/L (dissolved) and 1,000 mg/L (total).

E8.2.2.2 Antimony

Antimony is not an essential nutrient for animals or plants. It is relatively abundant in the earth's crust. Environmental toxicity is rare (Jones *et al.*, 1990) and little is known of toxic mechanisms. Taken orally, antimony has been known to disrupt blood glucose regulation and shorten life spans of experimental animals. Antimony has also been used in treatment of helminth and protozoan parasitic infections where it apparently disrupts glucose metabolism in these organisms. The RfD developed by EPA for protection of human health is based on an LOAEL of 0.35 mg/kg-day developed from studies on rats (EPA, 1993). Using the procedures outlined in Section E5, the ingestion rate TRV would be estimated at 0.1 mg/kg-day.

Mechanisms of phytotoxicity are unknown. Phytotoxic levels in plant tissues are estimated at 5 to 10 mg/kg dry weight (Jones *et al.*, 1990). Uptake ratios from soils range from 0.0005 to 0.1. Thus, potentially phytotoxic soil concentrations could range from 50 to 1,000 mg/kg.

Mean antimony concentrations at OU1 did not exceed background concentrations for any abiotic media. However, maximum concentrations in subsurface soil (57 mg/kg) and groundwater (210 mg/L) did exceed background. The maximum antimony concentration in surface soil did not exceed RFP background.

Based on the OU1 site-wide mean in subsurface soil (12.3 mg/kg in colluvium), a deer mouse feeding on vegetation within the OU1 IHSS area would ingest 0.2 mg/kg-day which is above the estimated TRV. However, the RFP background concentration (18 mg/kg) would result an even higher ingestion rate (0.3 mg/kg-day). Thus, the risk of antimony poisoning in OU1 is not greater than that in unimpacted areas of the site. If the mouse fed exclusively in the area of maximum antimony concentration, it would ingest approximately 1 mg antimony/kg-day. However, the area of OU1 containing this level of antimony is much smaller than the home range of even an individual mouse and, therefore, would have minimal impacts on mice in the area.

The maximum soil concentration is slightly greater than the lowest concentration identified as potentially phytotoxic. The restricted nature of the contaminated areas suggests the potential for only localized toxicity not likely to disrupt the integrity of the overall plant community at OU1.

Antimony does not appear to present a risk to wildlife at OU1. The areas of OU1 with elevated antimony concentrations are restricted to two sampling sites. Furthermore, the exposure to antimony within OU1 appears to be lower than that in unimpacted areas of Rocky Flats. Antimony does not bioaccumulate. Therefore, it also is not expected to cause toxicity to local wildlife through food chain transfer.

E8.2.3 Exposure Assessment

As noted in Section E1 (Introduction), a screening approach was taken to estimate risks in the OU1 EE. Empirical data from OU1 were used in calculating exposures wherever possible. The overall goal of the exposure assessment was to predict exposures as accurately as possible, but simplifying assumptions were necessary to avoid underestimating exposure. The assumptions are detailed in the text of previous sections and summarized in Table E8-1.

E8.2.3.1 Direct Exposures

In assessing direct contact with contaminants in soil and groundwater, it was assumed that all of the chemical measured in the samples was of a form that was potentially available for exposure. This is important because soil and groundwater samples were analyzed for total metal and radionuclide content including that portion which is incorporated into the matrix of the geologic materials and not available for transfer to biota. Generally, only a portion of the total available content is actually assimilated. Complete absorption is a more reasonable assumption for many of the organic compounds, but it overestimates the exposure for metals and radionuclides. The form of the chemical in environmental media is also important in assessing bioavailability. As discussed for selenium, the bioavailability of a chemical can vary greatly with the elemental state and/or complexing with organic chemicals. Therefore, the assumption of total availability is likely to overestimate the actual exposure. As soil and sediment samples were analyzed for total content, however, the form and relative proportions of various chemical combinations were not available for inclusion in the exposure estimations.

The frequency and duration of contact between plant roots and contaminated groundwater is important in determining the potential toxic effects. The predominant vegetation in the contaminated areas of OU1 are grasses and forbs whose roots are concentrated in the upper 30 cm of soil although certain species may have deeper roots. Depth to groundwater varies with topography and season, but is generally no closer to the surface than about 2 m. However, the proportion of the vegetation community in contact with groundwater contaminants at a given time is not easily quantifiable. The continuous exposure of vegetation roots to contaminants in groundwater, therefore, overestimates the contact of shallow-rooted species.

Animal burrows were assumed to be closed systems when estimating the concentration of VOCs in the air inside of the burrows. This assumption was made because it not feasible to accurately estimate the rate of exchange with outside air. The air in animal burrows is relatively restricted. Therefore, the concentration calculated for VOCs in burrow air is probably not a large overestimate, but it is very unlikely to be an underestimate.

E8.2.3.2 Indirect Exposures

Exposure through indirect pathways such as ingestion of contaminated food or water was estimated through the use of simple models. The use of models was necessary because tissue sample data were not available from the upper trophic levels in the local food web. Results of such sampling would be inconclusive as most of the predators acquire resources from areas much larger than OU1 and could be exposed to the same contaminants from other areas outside of RFP. Models were used to estimate the potential exposures due to sources in OU1.

The behavior of natural organisms and systems is often very complex and contains a significant stochastic component. In addition, it is usually not practical or feasible to collect data from all components of the system. Therefore, simplifying assumptions are required for most models, no matter how complex. The assumptions made in the exposure assessment for this investigation were chosen to be conservative and minimize the chance of underestimating the actual exposure. The potential effects of important assumptions are discussed below and listed in Table E8-1.

As noted for direct exposure, while total concentrations of contaminants were measured in abiotic and biotic media, not all of the contaminant is typically bioavailable and assimilated by higher-level consumers. This is particularly important for selenium and the radionuclides contained in vegetation and prey species. Ingestion models assumed that all selenium contained in vegetation, terrestrial arthropods, and small mammals was assimilated by the herbivores and omnivores ingesting them. Organically transformed selenium is readily absorbed and assimilated by many organisms, but the inorganic forms are considerably less bioavailable. Since the relative amounts of organic and inorganic selenium were not known, it was assumed that all selenium was assimilated. This is undoubtedly an overestimate of the available selenium, but even given this assumption, the amounts of selenium posed little or no risk to receptors. Furthermore, and perhaps most importantly, the selenium content of biota from OU1 was not significantly greater than that of biological samples from the reference area (Table E6-4). Risks due to ingestion of selenium with vegetation or prey are no greater in the OU1 area than in the reference area.

Radionuclide concentration of biota samples was measured as whole-body content. This approach was used because consumers normally ingest their food entirely and therefore take in any radionuclide that may be adhering to the external surfaces as well as that portion that was internalized. The assimilation efficiency was adjusted to 0.001 according to results of previous studies including those conducted at RFP (see Section E5). However, as noted previously, the internal dose rates were not adjusted for the adhering component. This assumption overestimates the radiation dose received from plutonium because the alpha emissions do not penetrate to living tissue from external surfaces and are greatly attenuated in gut contents. Since 90 percent of the total plutonium content may be attributed to these compartments, the dose received may be overestimated by a factor of 5 to 10.

As noted previously, biological tissues were not analyzed for PCBs because the presence of this contaminant was not anticipated. Therefore, the concentration of PCBs in small mammal and plant tissue was estimated using BCFs obtained from other studies of PCB-contaminated sites. The site-wide average concentration of PCBs in soils was used to estimate exposure because the upper-level consumers subject to biomagnification of PCBs would feed over large areas. The site-wide average included all "U"-qualified (non-detect) samples by assuming the concentration in these samples was one half of the detection limit (see Appendix D of the OU1 Phase III RFI/RI Report). PCBs were detected in only 3 of 27 sites. Therefore, the site-wide mean PCB concentration in soils may be overestimated, resulting in an overestimate of the exposure through ingestion of flora and fauna from the site. Even given this conservative assumption, the risks due to PCB uptake were negligible.

The ingestion models used to calculate uptake rates assumed that consumers used the OU1 area at a constant rate during the period of exposure. Site use varies seasonally and with daily behavior patterns. This is especially true for large, wide-ranging receptors such as the coyote, mule deer, and red-tailed hawk. Furthermore, the total body burden of a given receptor is dependent upon intake rate and elimination rate. Therefore, body burdens may be significantly reduced during periods spent away from OU1, effectively reducing exposure. It is also possible that there are periods when receptors may use the OU1 area more intensively and, therefore, increase uptake relative to elimination. Given the size of OU1 and the quality of resources there, however, the constant site use assumption probably results in an overestimate of exposure over time.

Table E8-1

Sources of Uncertainty and Their Potential Effects on Derivation of Ecological Effects Criteria Development and Exposure Estimations

Source	Effect	Remark
Toxicity Assessment		
1. Contaminant identification process	Manganese and antimony not selected as contaminants or COCs	Manganese and antimony were eliminated based on statistical criteria. Levels at OU1 do not appear to represent an ecological risk.
2. Tissue analytes identified before contaminants known	Data on chemicals concentration in biological tissue not available for some COCs	BCFs and transfer coefficients from the literature were used in modeling uptake of some COCs.
3. Lack of specific toxicity information for exposure of Rocky Flats species to COCs	May over- or underestimate critical effects concentrations	See item 2
4. Use most sensitive species in literature to set TRV	May over- or underestimate critical effects concentrations	Data for most sensitive species used to protect greater number of species
5. Estimation of NOEL from other data	May over- or underestimate critical effects concentrations	Results in protective values when combined with item 2

Table E8-1
(Continued)

Sources of Uncertainty and Their Potential Effects on Derivation of Ecological Effects Criteria Development and Exposure Estimations

Source	Effect	Remark
Exposure Assessment		
6. Abiotic sampling not designed specifically for ecological risk assessment	Data on chemical concentrations in abiotic media may not represent true exposure point concentrations	The exposure assessment adopted a screening level approach that is based on conservative assumptions and is designed to minimize chance of underestimating exposures.
7. Assume constant contact of roots with contaminated groundwater	May overestimate exposure of vegetation to VOCs in shallow groundwater	Phreatophytic species may maintain constant contact with groundwater, but species in areas of VOC contamination are primarily grasses and herbaceous forbs.
8. Assume all chemical in abiotic and biotic samples is bioavailable	May overestimate exposure to radionuclides and selenium	Not all contaminants taken up are assimilated. This is especially true for metals which form significant portions of natural rock matrices.
9. Assume equilibrium between VOCs in soil and burrow air	May overestimate concentration of VOCs in burrow air	Burrows are usually not closed systems. Therefore, diluting effect of exchange with ambient air not included in exposure estimate.
10. Assume concentration of PAH in small mammals is equal to that of soil	May overestimate tissue concentration and exposure of upper-level consumers	Literature BCFs for transfer of PCBs and PAHs from soil to plants or animals is usually less than 1.
11. Assume constant rate of ingestion and site use in estimation of exposures	May overestimate exposures	Site use probably is not constant, especially for larger, wide-ranging species. Extensive physiological elimination of chemicals can occur when receptor is not using the site.
12. Assume assimilation efficiency for uptake of selenium is 100% (a=1)	May overestimate exposures to selenium	Efficiency of selenium uptake varies with form; it is usually much less than 1 for inorganic forms, but approaches 1 for organic forms. Selenium in groundwater is likely to be inorganic.
13. Assignment of frequency distributions in simulation modeling	May over- or underestimate probability of exceeding critical value	Mean values are probably not affected, but values in "tails" of distribution may be over- or under-represented.
14. Use of mean ingestion rates, body weights, and home range sizes in simulation modeling	May over- or underestimate probability of exceeding critical value	Means were used because data from literature were not amenable to statistical analysis.

Table E8-1
(Continued)

Sources of Uncertainty and Their Potential Effects on Derivation of Ecological Effects Criteria Development and Exposure Estimations

Source	Effect	Remark
15. Assume sitewide mean concentrations in soils when greater than 50% of samples are non-detects	May overestimate sitewide exposure to contaminants through ingestion of soil, vegetation, or small mammals	This is particularly true for PCBs and some PAHs. Mean concentrations were calculated using one-half the detection limit for "U"-qualified data.
16. Assume literature values for BCFs for transfer of PCBs from soils to invertebrates and vertebrates	May over- or underestimate ingestion rates and probability of exceeding critical value	Transfer coefficient often is less than one.
Ecological Effects Assessment		
17. Reference area for reclaimed disturbed and grassland not available	Makes evaluation of ecc ogical impacts with respect to natural systems difficult	Risk characterization was based on results of exposure assessment and research on succession in reclaimed grasslands.
18. One season of data on community composition and population density estimates	Natural year-to-year variability in ecological parameters not included in assessment of ecological impacts	Risk assessment is based on "snap shot" of ecological communities. This is not as important for chemical data.
19. Temperature variation in aquatic toxicity screens	Reliability of toxicity screen results is reduced	Toxicity testing done only to assess gross contribution from OU1. More extensive testing of Woman Creek to be conducted during OU5 RFI/RI.

SECTION E9
CONCLUSIONS

E9.1 INVESTIGATION APPROACH AND GOALS

The OU1 EE was a source-driven investigation in that the location of the potential source was known (see Section E1), but evidence of ecological effects or toxic exposures was not apparent prior to field investigations (Suter, 1993). The locations of the OU1 IHSSs were identified on the basis of historical information, aerial photographs, and preliminary site data. Aerial photographs indicated some physical disturbance in IHSSs 119.1 and 119.2 when the sites were being actively used as waste storage areas and there was some evidence of past disturbance around IHSS 104. There were no overt signs of physical or chemical stress to vegetation or wildlife just prior to the initiation of Phase III RFI/RI field activities in 1991. Thus, the motivation for the investigation was not effects-driven. The nature and distribution of site contaminants was not conclusively known before Phase III results became available. Therefore, known exposure of ecological receptors to toxic chemicals was also not a driving force in the investigation.

The goals of the investigation were to identify potentially ecotoxic contaminants at OU1 and, where possible, quantify exposure and impacts to ecological receptors. Due to schedule constraints, the ecological field investigation had to be completed prior to identification of site contaminants. The approach to the investigation was to assess ecological stress through general indicators of community health, to identify COCs on the basis of available abiotic data, and to estimate exposures to COCs based on chemical concentrations in abiotic media and biological tissues.

Impacts due to toxic exposures were assessed using a screening level approach designed to minimize the chance of underestimating risks. Risks were characterized by comparing exposures estimated for receptors at OU1 to benchmark values derived from the scientific literature to indicate ecologically "safe" exposures. Conservative assumptions adopted in estimating exposures and in developing benchmark values serve to minimize chances of underestimating exposures. Methods for developing benchmark values are described in Section E5; methods for estimating exposure are described in Section E6.

E9.2 COCs IN ENVIRONMENTAL MEDIA

E9.2.1 Abiotic Media

The abiotic media assessed for contamination were surface and subsurface soils, shallow groundwater, and surface water and sediments in Woman Creek and the SID. COCs found to exceed critical concentrations in abiotic media are discussed below and summarized in Table E1-1.

The chlorinated hydrocarbons. TCA, TCE, DCE, PCE, and carbon tetrachloride were detected in groundwater at concentrations potentially toxic to plants through contact with roots. The areas with potentially toxic concentrations were restricted to two sampling sites in IHSS 119.1 covering about 0.03 ha (Figure E6-11). Each of these compounds is less dense than water and may tend to concentrate at the top of the water table. The depth to groundwater in the identified areas ranges from 2 to 4.5 m during spring and early summer and is approximately 1 m lower (deeper) during drier times of the year.

Toluene was widely distributed in soils at OU1, and the concentration at some sampling sites exceeded the EEC for exposure of burrowing mammals to contaminants in the burrow air (Figure E6-12). These sites were predominately outside of OU1 IHSSs. The total area of the Thiessen polygons representing the contaminated area was approximately 2 ha. Toluene volatilized from soils may accumulate in burrows thus exposing the inhabitants to potentially toxic levels. However, toluene has noxious effects at concentrations lower than those resulting in chronic toxicity. Therefore, exposure may be mitigated by avoidance responses of burrowing species.

PAHs were detected in soils at OU1. Soils around IHSSs 104 and 130 contained concentrations of benzo(a)pyrene, benzo(a)anthracene, and phenanthrene that could potentially result in skin cancer in burrowing animals. The area covers approximately 2 ha (Figure E6-13). The young of animals that rear their offspring in burrows, such as deer mice, may be most vulnerable to this exposure. Reduced survival or reproductive fitness of offspring could have adverse impacts on the local population. PAHs were also detected in sediments of the SID, but concentrations did not exceed EPA SQCs (Table E5-16).

The PCBs Aroclor 1248 and 1254 were detected in soils in IHSSs 119.1 and 119.2 at levels exceeding the EEC derived for the biomagnification pathway (Figure E6-14). The Thiessen polygons representing this area cover approximately 2 ha, or about 2 percent of the OU1 ecological study area. The effects criterion was derived to protect top carnivores in the area from toxicity due to chronic ingestion of PCBs in prey. Most vertebrate predators forage in areas much larger than that found to be contaminated by PCBs. For example, the "home range" of the great horned owl is approximately 100 ha and is the smallest of the predators featured in this risk assessment (see Attachment E-1). Thus, the owl would spend 2 percent of its foraging effort in the PCB-contaminated area of OU1 and other predators would spend proportionately less time there. The exposure analysis also included assessment of ingestion rate and potential bioaccumulation by predators at the site. The probability of any of the receptors exceeding the TRV for ingestion rate was estimated to be much less than one percent (Figure E6-15).

PCBs were detected in sediments at two locations in the SID, but the concentrations did not exceed EPA SQCs (Table E5-16). PCBs are known to bioaccumulate in aquatic systems. However, as noted previously, the aquatic habitat in the SID is restricted and of poor quality. The presence of water is intermittent, and the SID supports no fish population. However, some aquatic invertebrates colonize the area when water is present. Terrestrial species feeding in the temporary pools could ingest contaminants with their prey.

E9.2.2 <u>Biological Tissue</u>

Tissue contaminant loads are important for evaluating toxicity of chemicals that tend to bioaccumulate. This information is also important for radionuclides because once internalized, radioactive chemicals continue to deliver a radiation dose to the surrounding tissue, and the effects of the radiation exposure are cumulative. Biological tissues were analyzed for selenium and the radionuclide COCs. As noted previously, tissues were not analyzed for PCBs and PAHs because they were not believed to be present.

The concentration of selenium in biological tissues from OU1 was not significantly greater than that in samples collected from reference areas (Table E6-4). Therefore, the elevated selenium concentrations in groundwater were apparently not being transferred and bioaccumulated in biological tissues. Radionuclide concentrations were higher in samples collected from OU1 than in reference area samples (Table E6-4). However, as noted in Section E6.3.1.2, the doses corresponding to the tissue concentrations were several orders of magnitude below the TRV (Table E6-14).

The potential bioaccumulation of PCBs was evaluated by estimating the potential whole body concentrations that could result from feeding in the OU1 area for 1 year. Those values were then compared with the MATC of 0.6 mg/kg bw. The probability of exceeding the MATC was less than 5.7 percent for the great horned owl, less than 3.4 percent for the red-tailed hawk, and less than 1 percent for the coyote (Table E6-17).

E9.3 EVALUATION OF ASSESSMENT ENDPOINTS

E9.3.1 Vegetation

The concentrations of COCs in soils at OU1 did not appear to represent a risk to vegetation (see Sections E4 and E5). Concentrations of VOCs in groundwater were potentially toxic to plants having roots that contact shallow groundwater. Two areas in IHSS 119.1 exceeded EECs for carbon tetrachloride, TCA, TCE, DCE, and PCE (Figure E6-11). The identified sections of IHSS 119.1 cover about 0.04 ha, approximately 0.04 percent of the OU1 study area. The extent to which plant roots actually contact contaminated groundwater at OU1 cannot be quantified. As noted earlier, the depth to groundwater in the IHSS 119.1 area varies from 2 to 4.5 m during wetter seasons and from 3 to 5.5 m during drier seasons. The vegetation around IHSS 119.1 is predominately herbaceous, with roots concentrated in the upper 30 cm of soil. Under these conditions, most of the root mass will not frequently contact contaminants in groundwater, if at all. However, more deeply rooted shrubs or trees could maintain relatively continuous contact with groundwater, should they be present in this area in the future.

Tree and shrub cover is extensive in the riparian corridor along the Woman Creek channel approximately 100 m south of IHSS 119.1. Because the site is located in the drainage of Woman Creek, it is possible that contaminants in OU1 groundwater could be transported to the riparian area. However, the French Drain was installed in 1992 to intercept contaminated groundwater. Monitoring wells downgradient have been predominately dry, indicating the effectiveness of the action. Therefore, the risk of contaminated groundwater reaching roots of vegetation in the Woman Creek riparian corridor appears to be minimal.

The OU1 IHSSs were located primarily in mesic and reclaimed grassland communities, with portions of IHSSs 130 and 104 in xeric grassland, and the entire IHSS 103 in a small disturbed land margin (Figure E9-1). The area specifically identified for potential toxic effects to vegetation (IHSS 119.1) was located in the reclaimed grassland community type.

Community compositions of the mesic and xeric grasslands in OU1 were evaluated by comparing them with similar communities in the reference area. Data for the mesic grassland community reflected few differences between the OU1 study and reference sites. Significantly lower basal cover in the study area was attributed to less cover by the dominant native grasses. A paucity of trees, shrubs, and cacti in the study area suggested it has experienced surficial disturbance, or fire, in the past.

While the xeric grassland community type covers extensive areas of Rocky Flats (see Section E2 and DOE, 1992), it is a minor component of OU1. Portions of IHSSs 130 and 104 were located within xeric grassland. Although the exposure assessment for this area did not predict toxicity of groundwater, the xeric grassland partially coincided with an area identified as having PAH levels exceeding EECs for dermal exposure to animals (Figure E6-13). However, available data suggest that PAHs are relatively non-toxic to plants in dry soil conditions such as are prevalent in this grassland. The small area of xeric grassland in OU1 was of generally poor quality with a larger amount of exposed rock, lower cover, lower diversity, fewer woody species and cacti, and more weedy species than the reference area. These characteristics are consistent with the history of physical disturbance.

Reclaimed grassland is the second most common vegetation community in OU1. IHSS 119.1 is located within this community. The vegetation in the area now classified as reclaimed was probably similar to the OU1 mesic and xeric grassland communities prior to the initial disturbance and subsequent reclamation. The reclaimed grassland community is similar to OU1 xeric grassland in terms of cover, species richness, and woody plant density but is unique in terms of species composition. Although no written record exists of reclamation activities in this area, its species composition and distribution are undoubtedly the results of such activities.

A common goal of revegetation efforts is to introduce competitive species that will both stabilize the exposed soil quickly and exclude ruderal species (Redente and Depuit, 1988). The dominant plants in the OU1 reclaimed grassland, smooth brome and intermediate wheatgrass, are two of the most commonly used species in grassland reclamation (Brown and Wiesner, 1984). These grasses have undergone intensive selection and breeding and are noted for their rapid establishment and successful competitive exclusion of other plants, especially when planted in monocultures, as was the common practice in the past. Although dominant in the reclaimed areas, these grasses are uncommon in the other OU1 grassland communities. This is important because the adjacent mesic and xeric grassland communities would have been the source for natural revegetation of the reclaimed area, had it not been artificially seeded.

Soil disturbance in grasslands disrupts the established vegetation dynamics and provides an opportunity for new species to enter the site. Such disturbance may promote invasion by non-native and weedy plant species (Smith, 1988; Hobbs and Huenneke, 1992). Furthermore, it is difficult for native grasses to reestablish after soil disturbance (Krause, 1977; Brown and Wiesner, 1984). For this reason, site cultivation (soil disturbance) is usually avoided when attempting to restore native grassland vegetation (Burton *et al.*, 1988).

The lack of reestablishment by native plant species in the reclaimed grassland is not unexpected in when the land use history of OU1 is considered. However, it is possible that this trend has been exacerbated by the presence of chemical contamination of groundwater. No vegetation sampling within IHSS boundaries was permitted at the time of this study. However, one vegetation sampling site (MR03A) was located approximately 30 m to the north of IHSS 119.1. Transects at this site exhibited an anomalous cover pattern compared to the other sampling sites in reclaimed grassland. Site MR03A had a considerably lower total cover value than the other reclaimed sites (14.5 vs. an area mean of 19.8 percent). Smooth brome accounted for 97 percent of the vegetative cover, with field bindweed contributing the remaining 3 percent. This pattern could be a response to contaminated groundwater. However, this seems unlikely given the depth to groundwater and the relative shallowness of grass and forb roots. The physical disturbance associated with the removal of contaminants, or simply the spatial heterogeneity common in any grassland, may better explain the disturbances.

Except for a diagonal strip through the center of OU1, suggestive of a road, areas of disturbed land were located primarily along the margins of the reclaimed grassland. This fact, along with the quality and species composition of this community, suggest that these areas of disturbed land are an ecological result of reclamation and physical disturbance.

IHSS 103 is located within a disturbed land area. Because the exposure assessment identified no areas of concern to vegetation in this IHSS, it is likely that the vegetation patterns present in the area are a result of land use and not contamination.

E9.3.2 Small Mammals

Small mammals were selected as an assessment endpoint because they are important components of the local food web, are found in a wide range of environmental conditions, and have home ranges such that individuals found in OU1 probably spend most or all of their lives there. In addition, tissue samples and data on presence and abundance can be collected relatively easily.

Exposure of small mammals to COCs was assessed using a variety of methods (see Section E6). Dermal and respiratory exposure to contaminants in subsurface soil was assessed because the young of many species are reared in burrows and spend long periods of time in contact with subsurface soils. The rate of ingestion of COCs during consumption of vegetation or arthropod prey was estimated and compared to potentially toxic levels. Radiation dose rates were calculated using tissue concentrations measured in samples. Potential bioaccumulation of PCBs was also assessed, although concentrations were not measured in tissue samples collected from the site.

No significant toxicity was indicated by estimated tissue concentrations, ingestion rates, or potential bioaccumulation of COCs at OU1. The concentration of some PAHs exceeded the EEC for dermal exposure at two sample locations representing about 0.3 percent of the OU1 ecological study area (Figure E6-13). Respiratory hazards were restricted to toluene concentrations in subsurface soils representing about 2 percent of the OU1 area. PCB concentrations in soils exceeded the critical soil concentrations at three sampling sites representing approximately 2 percent of the OU1 ecological study area (Figure E6-14). The home range of a deer mouse is typically no more than 1 to 2 ha. Thus, areas in which soil contaminant concentrations exceed effects criteria could represent exposure to a relatively few individuals.

Deer mice and voles were generally more abundant in the four native community types in the reference area than the study area (Tables E7-9 and E7-10). However, total small mammal abundance was higher in the reclaimed grassland than in either grassland community in reference or study areas regardless of season, with the single exception of the reference mesic grassland in fall. Habitat quality for small mammals did not appear to be adversely affected by either the presence of contaminants or the absence of native grasses in the reclaimed grassland. In addition, a species of special concern, Preble's jumping mouse, was present in this habitat type. A discussion of the status and habitat of this species can be found in Section E9.3.6.

Water shrews were also captured in the Woman Creek drainage including the area around Pond C-1. This species is relatively common in montane areas above 7,000 feet in Colorado, New Mexico, and Wyoming, where it inhabits stream and pond margins and feeds on aquatic insects, small fish, and carrion. Its presence on Rocky Flats is notable since it seems to require the clean water and relatively undisturbed habitat found in montane coniferous forests. Shrews are voracious feeders, and any contaminants transferred in the food web may accumulate more rapidly than in other predators. Water shrews are particularly susceptible since they feed in aquatic habitats where the potential for bioaccumulation is very high. Therefore, the presence of water shrews along Woman Creek and Pond C-1 would seem to indicate a relatively clean environment.

E9.3.3 Mule Deer

Mule deer were included in the assessment endpoints because they are important primary consumers in the grassland ecosystems at Rocky Flats and because a healthy deer herd is recognized as a sign of a relatively healthy environment. Mule deer have been observed using areas downgradient of OU1 and could potentially be exposed to site contaminants through ingestion of vegetation, surface water, and soils.

Exposure of mule deer to selenium and radionuclides in food, water, and soil was assessed using the concentrations measured in samples collected from OU1. Ingestion of PCBs and PAHs were assessed using the same approach as noted for small mammals. Results of simulation modeling indicate that there is very little chance that the rate at which site contaminants are ingested could lead to toxic effects (Table E6-8 and Figure E6-6). These low ingestion rate estimations are due in part to the large home range that mule deer normally use and the relatively low levels of contamination at OU1. Mule deer could also be subject to dermal exposure to PAHs in surface soils if they were to lie down in contaminated areas. However, the areas of highest PAH concentrations are located in an area of high vehicle traffic and other human activity. The area is also highly disturbed and on a steep hillside. Thus, deer are unlikely to use these sites as bedding areas.

Quantitative data on mule deer abundance were not used for comparisons of OU1 with the reference area for two reasons. First, habitat differences not related to contamination would make such comparisons difficult to interpret. Second, deer have very large home ranges and thus may not be good indicators of conditions within a small area such as OU1. However, qualitative assessments indicated that mule deer are unlikely to have been adversely impacted by OU1 contaminants. Upland habitats in both OU1 and the reference area are of limited quality for deer because of the near-absence of shrubs for food or cover. In contrast, the riparian habitat along Woman Creek, including the reach near OU1, is suitable for deer because of the combination of lusher vegetation, water, and tall shrubs or trees for thermal and hiding cover.

Deer were regularly observed along Woman Creek and adjacent hillsides and appeared to be healthy and to be reproducing normally.

E9.3.4 Predators

Toxic exposure to species representing the top predators in the Rocky Flats food web were included in the assessment endpoints because of the need to evaluate potential bioaccumulation. Predators were also included for their societal recognition as sensitive ecological receptors. The coyote, red-tailed hawk, great horned owl, and bald eagle were assessed for ingestion of contaminants with their prey and the potential accumulation of contaminants in tissue.

Ingestion of selenium and radionuclides was assessed using site data on tissue concentrations in small mammals. PAH and PCB ingestion was assessed assuming transfer of PCBs from contaminated soil to small mammal tissue. Bioaccumulation potentials also were assessed. The probability of exceeding any of the critical ingestion rates was low or negligible for most of the predators and COCs (Figure E6-15). The highest probability, approximately 13 percent, was associated with ingestion of selenium by great horned owls. This results from the fact that the owl was assumed to feed entirely on mice and voles from the OU1 area. However, as noted in Section E6, the concentration of selenium in mice and voles from OU1 was *not* higher than those from the reference areas. Therefore, the chance of selenium poisoning is not greater in OU1 than in the unimpacted native areas of Rocky Flats.

Similar to birds of prey, coyotes are generally long-lived and thus, over their lifetimes, could potentially be exposed to a larger mass of contaminants. Additionally, they are capable of consuming larger prey than the raptors, including young or miscarried deer and other predators such as red foxes. Qualitative surveys indicated that coyotes were common along the Woman Creek corridor, and they almost certainly preyed to some extent on animals (and vegetation, especially fruits) within OU1. Habitat within OU1 did not appear to be of significantly lower quality than the reference area, except for the greater cover by shrubs and topographic relief associated with Rock Creek. The generally lower cover and richness of the study area habitats was not reflected in dramatically lower small mammal abundances, except for the weedy and depauperate xeric grassland habitat type (Tables E7-9 and E7-10).

The relatively modest differences in small mammal abundance also bear on habitat quality for red-tailed hawks and great horned owls. In prairie environments, these species may be limited by the availability of suitable nest sites, particularly trees, cliffs, or (in the case of the owl) abandoned buildings. Both red-tailed hawks and great horned owls were frequently observed along the Woman Creek riparian corridor near OU1, although neither is confirmed to have nested in the immediate vicinity—possibly because of the high level of human activity. Dietary habits of these large raptors are mostly associated with temporal niche partitioning; that is, hawks feed during the day, and owls feed during the night. Thus, hawks consume a larger proportion of diurnal prey including snakes (which are predators). Owls may consume larger prey, including rabbits (which are longer-lived than mice) and small predators such as coyote pups and feral cats.

The ability of owls to meet their dietary needs with a smaller home range than hawks is attributable primarily to the fact that nocturnal hunting coincides with the period of greatest activity by small mammals. In addition to having larger hunting territories, hawks are migratory and thus consume only a portion of their annual food intake in a given area. In contrast, great horned owls are nonmigratory. As with coyotes, any differences in habitat quality for red-tailed hawks and great horned owls between the study area and reference area are related primarily to physical habitat characteristics and not to contaminant effects on their individual health or on their prey base.

E9.3.5 Aquatic Life

Aquatic resources within OU1 are limited to sections of the SID. As noted previously, the SID was constructed to intercept surface runoff and shallow groundwater from OU1 IHSSs thus preventing contaminants from reaching Woman Creek. Some temporary pools within the SID support aquatic invertebrates, but the habitat quality of these sites is limited by the lack of permanent water and low structural diversity. Flow within the SID is directed into Pond C-2 which has no outlet and is the terminal point in the system. Pond C-2 was constructed to store water from the SID until it could be treated in granular-activated carbon (GAC) filters and pumped to Pond B-5. Woman Creek has been diverted such that no flow from it enters Pond C-2.

SID and Pond C-2

Sediments of the SID contained the PAH phenanthrene and PCBs, but concentrations did not exceed SQCs; surface water concentrations also did not exceed standards. Contamination in sediments appears to represent little hazard to ecological receptors. This area of the SID is a relatively minor ecological resource because of the small amount of prey available there and because the much richer habitat along Woman Creek is located nearby. There was some sign that raccoons had taken crayfish from some sections of SID. However, the crayfish population in these temporary pools was small and not likely to support foraging by raccoons or other predators long enough to result in significant exposures.

Because Pond C-2 was built to receive flow from the SID, OU1 contaminants could be deposited in surface water and sediments there. Surface water and sediment were not sampled from Pond C-2 for the OU1 RFI/RI, but evidence indicates a lack of contaminant effect. Aquatic toxicity screens conducted for the OU1 EE indicated a lack of toxicity to *Ceriodaphnia* and fathead minnows (Figure E7-6). Preliminary toxicity testing conducted for the OU5 -- Woman Creek Priority Drainage Phase I RFI/RI also indicates a lack of toxicity. Sediments also were tested for toxicity under the OU5 investigation and indicated no toxicity to *Hyalella azteca*. Moreover, fathead minnows, a standard EPA toxicity test species, were apparently thriving in Pond C-2 (Table E2-6). The lack of other fish species in this pond is probably due to the frequent manipulation of water levels, as the water level of the pond is lowered during releases. Severely lower water levels can result in lower dissolved oxygen concentrations and higher suspended solids, and make the vegetated littoral zones inaccessible to fish species that feed there. The resulting lack of predators and competitors may have contributed to the abundance of fathead minnows.

Woman Creek and Pond C-1

No section of Woman Creek is within the OU1 IHSS area, but it is possible that contaminants in OU1 could enter Woman Creek through surface runoff or subsurface transport in groundwater. The likelihood of the former was reduced with the installation of the SID to intercept surface flow. The installation of the French Drain has decreased the probability of groundwater transport. Monitoring wells downgradient of the French Drain have been dry indicating the effectiveness of this action.

No effects of OU1 contamination on Woman Creek were apparent. Water quality in Woman Creek has been consistently good (see Section 4.0, OU1 Phase III RFI/RI Report, Volume I). Aquatic toxicity screens conducted in 1991 indicated some toxicity to *Ceriodaphnia* at stream sites WORI3 and SW033. However, toxicity at sites upstream of OU1 was equal or greater (Figure E7-6). Therefore, the source of the toxicity could not be attributed to OU1, but may be due to upstream influences. Samples from Pond C-1 showed no toxicity to either *Ceriodaphnia* or fathead minnows. Preliminary results of full dilution-series toxicity tests conducted for the OU5 RFI/RI also indicate no toxicity of water from stream sites or Pond C-1 to *Ceriodaphnia* or fathead minnows. Likewise, sediments collected from stream sites and Pond C-1 showed no toxicity to *Hyalella azteca*. As noted in the Introduction, a complete analysis of toxicity and contaminant loading to Woman Creek will be conducted during the OU5 RFI/RI. A definitive study of contaminant sources and effects in Woman Creek requires a comprehensive, basin-wide analysis of hydrology and geochemistry. The preliminary aquatic sampling conducted for this investigation was meant only to assess potential impacts for OU1.

Data on the fish and benthic communities in Woman Creek correlate well with the results of toxicity testing. The benthic community richness, diversity, and EPT index were generally higher at sites adjacent to OU1 than at upstream sites (Table E7-12). These parameters are expected to increase with stream size and distance downstream from the stream source, especially in the headwater areas of a drainage (Ohio EPA, 1988). Thus, habitat quality changes with stream distance appear to follow a generally natural progression and does not appear to be adversely affected by OU1.

The FBI index changed only slightly with distance downstream and relatively intolerant species such as caddisfly and mayfly larvae were present at all sampling sites (Table E7-12). An abrupt change in habitat or water quality due to introduction of pollutants would result in a decrease in the abundance of intolerant species and/or an increase in tolerant species which would in turn result in a shift in the FBI index. Such a change was not apparent in Woman Creek as it passes OU1.

The ratio of scrapers to filterers and collectors is sensitive to the general abundance of suspended organic matter and fine particulate matter in a stream reach. Filterers and collectors need attachment sites typically provided by filamentous growth such as algae and mosses. The abundance of scrapers generally reflects the quality and diversity of the periphyton community. A shift in the ratio can indicate a change in habitat quality. This ratio varied greatly among sample stations. Filterers and collectors were more abundant than scrapers at all sites except SW033 where the relationship was reversed (Table E7-12). However, there was no clear trend with respect to OU1 contaminant sources. The significance of this result is unclear but may be related to local current velocities and attachment sites. Likewise, the ratio of EPT taxa to chironomid taxa was variable and may also be related to the variable current velocities and the resulting effects on substrate.

Pond C-1 is a small retention pond built on the main stem of Woman Creek. There is good structural diversity along the banks of Pond C-1 with dense stands of willows, cattails and bulrushes along the north bank and around the inlet. As would be expected, the benthos community of the impoundment showed lower richness and diversity than that of the stream sites. This is primarily due to the lack of current and the fine silty substrate and is typical of a lentic (standing water) environment. The benthic samples were dominated by dipteran larvae which is also expected from silty substrates. The cattail/bulrush stands on the pond banks contained mayflies, dragonflies (Odonata), diving beetles and other species that require the structural diversity of a vegetated littoral zone.

The fish community of Pond C-1 was surprisingly diverse for a small pond in the semiarid environs of Rocky Flats. Seven species of fish were identified in gill net and minnow trap samples (Table E2-6). Nearly all feeding guilds were represented in the species assemblage including the carnivorous largemouth bass and green sunfish. The presence of these species indicates that populations of fish and invertebrate prey are diverse and rich enough to support top carnivores. The species assemblage is also indicative of clean water as fathead minnows, stonerollers, and largemouth bass are relatively intolerant of pollution. The lower abundance of fathead minnows in Pond C-1 as compared to Pond C-2 is probably due to the presence of the larger bass and sunfish which may feed on the minnows.

In summary the overall habitat quality in Woman Creek does not appear to be adversely affected by contamination at OU1. Water quality in the creek has been consistently good, although no data currently exist for storm runoff events that could result in pulsatile introduction of contaminants into the creek. Volume and chemical content of storm runoff is being measured for the whole drainage under the OU5 RFI/RI. A basin-wide hydrologic model is also being developed. The potential for contamination of sediments with PAHs and PCBs is currently unknown, but sediments are also being analyzed in the ecological risk assessment for the OU5 RFI/RI.

The fish and invertebrate communities in Woman Creek are not consistent with the robust effects of water- or sediment-born pollution. The good habitat and water quality in the creek is probably due in part to the rich riparian community along the Woman Creek corridor at Rocky Flats. Healthy riparian areas are key factors in maintaining instream water quality, especially in the semiarid western United States. The Woman Creek riparian corridor supports many disturbance and contaminant sensitive species such as the Preble's jumping mouse, water shrews, and the bog orchid indicating a relatively intact community.

E9.3.6 Endangered and Candidate Species

Federally listed endangered species of potential interest at RFP are the black-footed ferret, peregrine falcon, and bald eagle (see Section E2.2.3). Black-footed ferrets do not occur at the site. Peregrine falcons are known to nest within 10 kilometers (km) but do not appear to use the site.

Bald eagles are irregular visitors; a pair initiated nesting east of RFP in 1993, but did not successfully breed. Eagles generally prefer fish but also take terrestrial prey such as jackrabbits, cottontails, and especially prairie dogs. Eagles are unlikely to feed within OU1 because of it represents a low quality resource for them. There are no significant aquatic resources in this part of the Woman Creek drainage and prairie dogs do not occur in OU1. Rabbits and other species may use the OU1 area, then travel to areas more likely to be hunted by eagles. An exposure assessment was conducted to evaluate the potential ingestion of OU1 contaminants by eagles hunting at Rocky Flats. The exposure estimate included two conservative assumptions:

(1) eagles feed on small prey (mice and voles) that spend all of their time within OU1, and (2) OU1 represents a food resource equal in quality to other parts of the eagle's home range. Even with these conservative assumptions and others associated with the general exposure assessment methodology, the exposure of eagles to OU1 contaminants was negligible.

Three Category 2 candidate species for listing have been observed at RFP: the ferruginous hawk, long-billed curlew, and Preble's meadow jumping mouse. Ferruginous hawks are vagrants that may occasionally hunt at RFP. However, OU1 is very small in relation to the size of a hawk's home range and contamination from the site, if any, would be trivial. Long-billed curlews are not known to occur at the site except for one sighting reported during fall migration in 1993. A Preble's meadow jumping mouse was captured within OU1, and a resident population is known from Rocky Flats. The status of Preble's meadow jumping mouse at Rocky Flats is discussed further below.

Preble's meadow jumping mouse (*Zapus hudsonius preblei*) is known only from New Mexico, Colorado, and Wyoming. Populations of this subspecies are relicts of a species that is broadly distributed across North America above 30 degrees latitude in the east and 45 degrees latitude in the west. Museum specimens of Preble's meadow jumping mouse collected since the turn of the century in Colorado show them to have occurred in an area encompassing seven counties that generally follow the drainage of the South Platte River and its tributaries (Armstrong, 1972).

In the past 20 years, meadow jumping mice have been captured in only five localities in Colorado, and their status is uncertain. In 1972 several meadow jumping mice were captured in Woodburn, El Paso County (Jones and Jones, 1985); this is south of any other capture locality in Colorado. At Fort St. Vrain Nuclear Generating Station near Longmont, three individual mice were caught, one each in 1972, 1976, and 1977. None were found in a 1992 search at the same site. On City of Boulder Open Space, three meadow jumping mice were captured in 1989 at the Tracy Collins parcel (adjacent to Coal Creek between Highway 93 and 128), and one was captured in 1992 at the VanVleet parcel (just south of Highway 36). At RFP, one individual was captured in 1991 by Woman Creek; 10 animals were captured in 1992 and 9 animals in

1993, in Rock Creek, Walnut Creek, and Woman Creek during jumping mouse surveys (EG&G 1992a, 1993); and one individual was recorded in 1993 in Smart Ditch.

The preferred habitat of this species is moist lowland communities with dense vegetation, including abandoned grassy fields, thick vegetation along ponds, streams, and marshes, and rank herbaceous vegetation of wooded areas. At RFP Preble's meadow jumping mouse favored the riparian willow shrub communities, dominated by coyote willow, lead plant, or western snowberry, within approximately 18 m of drainage channels (EG&G, 1992a; EG&G, 1993). The vegetation along Woman Creek adjacent to OU1 is dominated by coyote willow and cottonwoods and soils remain moist throughout the summer. The Woman Creek riparian corridor is, therefore, suitable habitat for Preble's jumping mouse. One individual was captured in the reclaimed grassland area of OU1, suggesting that grassland communities also may be used seasonally.

No management plans for meadow jumping mice currently exist. Grazing and the associated effects on riparian areas affect habitat quality. Livestock grazing at the Fort St. Vrain site may have negatively impacted this population to the point of extirpation (Pioneer, 1993). Grazing also occurs on the Boulder Open Space parcels (the Tracy Collins and VanVleet parcels). No grazing has occurred at RFP since at least 1972, and this is the only site where multiple captures have been made in consecutive years.

Results of the exposure assessment indicate risk from toxic exposure from OU1 IHSSs is probably not significant. The habitat most intensively used by this species does not contain any of the OU1 IHSSs or other sources of contamination. Preble's meadow jumping mouse probably does use grassland habitats to some extent, and may enter the OU1 IHSS area during some times of the year. However, the exposure analysis suggests that even if an individual mouse foraged exclusively in the IHSS area, exposures would probably not lead to significant adverse effects.

RFP is home to the largest known population of Preble's meadow jumping mice in Colorado. The lack of grazing and public access seems to have afforded protection to this species. Protection of the riparian corridors at Rocky Flats appears to be the most important factor in managing the population.

E9.3.7 General Habitat Quality

Two distinct components comprise the habitat quality of OU1: upland habitats and the Woman Creek riparian corridor. Native upland habitats (mixed grassland and xeric grassland) were generally of lower quality than the reference area in terms of cover, richness, and diversity. OU1 native grassland was somewhat weedy in character, perhaps because of its proximity to the industrial area or prior physical disturbance. Data did not suggest that differences were due to contamination. Other upland communities included reclaimed grassland and disturbed land. Although not desirable in terms of vegetation, both of these habitat types supported substantial use by small mammals. These two types almost certainly reflect the influence of prior disturbance—some of it partially rehabilitated (reclaimed grassland) and some of it not (disturbed land).

In contrast to the upland habitats, lowland types (marshland and riparian woodland) within OU1 were not of obviously poorer quality. Indeed, in terms of size and number of trees, the Woman Creek riparian zone was relatively well developed for a stream of its size. The lack of grazing for a prolonged period has resulted in significant reproduction of cottonwoods and willows and prevented trampling of the herbaceous understory. Use of the Woman Creek riparian zone by Preble's jumping mice, birds of prey, and mule deer is an obvious indicator of its value within the RFP prairie environment. Less obvious, but equally important ecologically, is the fact that the numerous mature trees attract a variety of small birds that would not occur otherwise. The same is true for shrubby and herbaceous (cattail/bulrush) wetlands in more open stretches of the creek. The SID does not offer such important habitat because of its very narrow nature and the nonpersistent flow of water. The new wetland area created as part of the French Drain Interim Remedial Action will increase the area of marshland habitat after it has become established and is expected to attract some species of wetland songbirds and small mammals that currently are restricted to areas along the creek and ponds.

Table E9-1

Summary of Contaminants of Concern Exceeding Ecological Effects Levels in Abiotic Media

COC	Environmental Medium	Receptor	TRV Exceeded	Areal Extent Exceeding TRV	Remarks	
Trichloroethane Trichloroethene Dichloroethene Tetrachloroethene Carbon Tetrachloride	Groundwater	Vegetation	Direct Contact with Roots	0.03 ha	These VOCs were detected in groundwater in IHSS 199.1. Area represents less than one percent of OU1 study area. Water table about 2 m below surface in area of contamination. Predominate vegetation in area is herbaceous with rooting depths of <0.3 m.	See Figure E6-11
Toluene	Surface and Subsurface Soil	Burrowing Mammals	Inhalation of Burrow Air	2.0 ha	Toluene was detected at widely distributed sites within OU1 but largely outside of IHSSs.	See Figure E6-12
Benzo(a)pyrene Benzo(a)anthracene Phenanthrene	Surface and Subsurface Soil	Burrowing Mammals	Dermal Contact	0.9 ha	Dermal contact TRV is based on carcinogenesis which may affect fitness by reducing the number of young surviving to reproduce.	See Figure E6-13
Phenanthrene	Sediments in SID	Aquatic Life and Terrestrial Predators	EPA Sediment Quality Criterion	n/a	The SID is poor quality aquatic habitat and supports a limited fauna. No fish are present because of intermittent nature of water in ditch. Some benthic organisms inhabit the SID and may serve as food source for terrestrial predators.	See Section E6.3.1.4
Polychlorinated Biphenyls	Surface Soils	Terrestrial Predators	Soil Criterion Based on Potential Bioaccumulation	2.3 ha	PCBs were associated primarily with IHSS 199.1 and 119.2. Contaminated area is small relative to the home range of most predators.	See Figure E6-14
Polychlorinated Biphenyls	Sediments in SID	Aquatic Life and Terrestrial Predators	EPA Sediment Quality Criterion	n/a	The SID is poor quality aquatic habitat and supports a limited fauna. No fish are present because of intermittent nature of water in ditch. Some benthic organisms inhabit the SID and may serve as food source for terrestrial predators.	See Section E6.3.1.5

SECTION E10

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ATTACHMENT E-1

LIFE HISTORY DATA FOR KEY RECEPTORS

Table 1
Life History Table for the Meadow Vole and Prairie Vole, Combined (*Microtus pennsylvanicus* and *Microtus ochrogaster*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	In Colorado these species occur around wetlands and in the vicinity of stream-side communities and irrigated areas.	Armstrong (1972)
Body Weight	Prairie Voles: 50.8 g (combined mean weight for n=17, from Armstrong 1972 and RFP data).	Armstrong (1972) EG&G data from RFP
Diet Composition	Assume 42% grasses, 40% forbs, and 11% seeds and fruit combined for both species. Meadow voles eat most available species of grass, sedge, and herbaceous plants, approximately 50% grass and 50% forbs average annual composition. Prairie voles eat primarily forbs (including stems, leaves, and underground parts), some grasses, and seeds and arthropods in smaller quantities, approximately 33% grasses, 30% forbs, and 23% seeds and fruit.	Reich (1981) Batzli (1985) Stalling (1990) Cole and Batzli (1979)
Food Ingestion Rate	Daily ingestion rate of dry matter (g/day = .621 (body mass in grams)$^{.564}$	Nagy (1987)
Water Ingestion Rate	Meadow voles consume 0.21 ml/g body weight/ day. Prairie voles consume 0.23 ml/g body weight/day.	Ernst (1968) Dupre (1983)
Home Range Size	Assume 1.8 ha for both species. Meadow Voles: 0.16-3.5 ha. Prairie Voles: 0.11-0.22 ha.	Van Vleck (1969) Stalling (1990)
Population Density	Characterized by cyclic fluctuations in population density with a period of 2 to 5 years. Densities may vary from a few animals per ha to hundreds of individuals per ha.	Krebs and Myers (1974) Gier (1967)

Table 2
Life History Table for the Deer Mouse (*Peromyscus maniculatus*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Ubiquitous in Colorado	Armstrong (1972)
Body Weight	18.7 g (n=116) RFP, November	EG&G data from RFP
Diet Composition	Seeds 71%; green vegetation 18%; other items included fungi, wood fragments, fur, mineral particles, and earthworms (Marshall Lake in Boulder). Seeds 75%; arthropods 14%, woody fragments 8% (Bummers Gulch, 8 mi. west of Boulder). Assume 73% seeds, 13% forbs, 9% arthropods, and 5% other.	Williams (1959a)
Food Ingestion Rate	Daily ingestion rate of dry matter (g/day) = .621 (body mass in grams)$^{.564}$, 0.14 g/g body weight/day (using empirical data).	Nagy (1987) Linzey (1987)
Water Ingestion Rate	0.22 ml/g body weight/day (at 10-20% relative humidity)	Williams (1959b)
Home Range Size	Males 0.21 or 0.33 ha (minimum three or four captures, respectively) Females 0.15 or 0.25 ha (minimum three or four captures, respectively)	Williams (1955)
Population Density	Variable, depending on season, habitat, food availability, predators, and presence of other small rodents.	Armstrong (in press), Merritt and Merritt (1980)

Table 3
Life History Table for the Mule Deer (*Odocoileus hemionus*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Occurs in all major habitat types in western North America except deserts and tundra.	Anderson and Wallmo (1984)
Body Weight	70 kg for adults	Anderson et al. (1974), Hunter (1947)
Diet Composition	Shrubs comprise 58%, forbs 29%, grass 6%, and other 7% of the diet over all four seasons combined.	Carpenter et al. (1979), Kufeld et al. (1973)
Food Ingestion Rate	0.022 kg air dry forage/kg body weight/day	Alldredge et al (1974)
Water Ingestion Rate	51 ml/kg body mass/day annual average for confined deer (24-35 ml/kg body mass/day in winter and 47-70 ml/kg body mass/day in summer).	Bissell et al. (1955)
Soil Ingestion Rate	16.1 g/deer/day	Arthur and Alldredge (1979)
Home Range Size	285.3 ha (n=110), calculated from several studies	Harestad and Bunnell (1979)
Population Density	3.9 animals/km^2 during winter in prairie-woodland riverbreaks in Montana	Mackie (1970)

Table 4
Life History Table for the Coyote (*Canis latrans*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Ubiquitous	Towry (1987)
Body Weight	12.75 kg (taken as midway point between 14 and 11.5 kg) 14 kg for males (range 8-20 kg) 11.5 for females (range 7-18 kg)	Bekoff (1977)
Diet Composition	90% of diet is usually animal matter (rabbits and rodents).	Bekoff (1977)
Food Ingestion Rate	0.047 g food/g body weight/day for adults 0.07 g food/g body weight/day for lactating females	Gier (1975)
Water Ingestion Rate	99 (body mass in kilograms)$^{0.9}$	Calder and Braun (1983)
Home Range Size	11.3 km^2 for residents and 106 km^2 for transients in southeastern Colorado, where 78% of individuals were residents and 22% were transients	Gese et al. (1988)
Population Density	0.2-0.4 animals per km^2 over a large portion of their range. One denning pair per km^2 was estimated as the maximum for eastern Colorado's rolling plains.	Knowlton (1972) Gier (1975)

Table 5
Life History Table for the Red-Tailed Hawk (*Buteo jamaicensis*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Open areas in a wide range of habitats, including scrub desert, plains and montane grassland, agricultural fields, pastures, urban parkland, broken coniferous and deciduous woodland, and tropical rain forest	Preston and Beane (1993)
Body Weight	1,126 g average for both sexes (1,028 g for males and 1,224 g for females)	Craighead and Craighead (1969)
Diet Composition	Diet is broad and includes voles, mice, rats, cottontails, snowshoe hares, black-tailed jackrabbits, ground squirrels, ring-necked pheasant, bobwhites, other birds, and reptiles. In Wisconsin, spring diet was 38% cottontails, 23% pheasants, 14% squirrels and muskrats, 10% small birds, and 7% voles and mice.	Preston and Beane (1993) Peterson (1979)
Food Ingestion Rate	0.12 g/g body weight/day	Palmer (1988) Craighead and Craighead (1969)
Water Ingestion Rate	59 (mass in kilograms)$^{0.67}$	Calder and Braun (1983)
Home Range Size	Breeding home range of 570-730 ha Winter home range of 162 ha	Smith and Murphy (1973) Peterson (1979)
Population Density	Population density varies from 0.17 to 6.4 hawks per km^2.	Preston and Beane (1993)

Table 6
Life History Table for the Great Horned Owl (*Bubo virginianus*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Lowland riparian forests and agricultural areas, and occurs in grasslands and shrublands while hunting	Andrews and Righter (1992)
Body Weight	1,505 g average for both sexes (1,304 g for males and 1,706 g for females)	Craighead and Craighead (1969)
Diet Composition	In Wyoming during summer, diet was 64% voles and 24% gophers (=95.6% mammals) and 4.5% birds. In Michigan during winter, diet was 88% small mammals.	Craighead and Craighead (1969)
Food Ingestion Rate	10.7% of body weight per day in fall and winter. 7.7% of body weight per day in spring and summer.	Craighead and Craighead (1969)
Water Ingestion Rate	59 (body mass in kilograms)$^{0.67}$	Calder and Braun (1983)
Home Range Size	Feeding ranges were within 1/2 km of nest.	Baumgartner (1939)
Population Density	One pair per 16 km^2 in winter one to three pairs per 1.6 km^2 all year	Craighead and Craighead (1969) Baumgartner (1939)

Table 7
Life History Table for the Bald Eagle (*Haliaeetus leucocephalus*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Habitat variable, dependent on food supply. Winter resident at low elevations in Colorado where it may occur locally in grasslands, especially near prairie dog towns.	Johnsgard (1990) Andrews and Righter (1992)
Body Weight	Males 4,123 g; females 5,244 g. Assume 4,685 g for both sexes.	Johnsgard (1990)
Diet Composition	Opportunistic feeders with considerable seasonal and locational variation. Fish (14% to 100%), birds (0% to 81%), and mammals (0% to 36%). At Rocky Mountain Arsenal, feeding observations showed the following dietary percentages: prairie dogs 52%; lagomorphs 17%; birds 6%; unknown 24%.	Johnsgard (1990) U.S.FWS (1992)
Food Ingestion Rate	Daily consumption of 500 g of salmon, 364 g of jackrabbit, or 296 g of duck required to meet daily energy requirements for a 4.5 kg bird.	Stalmaster (1987)
Water Ingestion Rate	59 (body mass in kilograms)$^{0.67}$	Calder and Braun (1983)
Home Range Size	660-6,400 ha per nesting pair in the breeding season. No figures available for winter.	Johnsgard (1990)
Population Density	Extremely variable outside of the nesting season.	Johnsgard (1990)

Table 8

Life History Table for the Meadow Jumping Mouse (*Zapus hudsonius*)

PARAMETER	VALUE AND COMMENTS	REFERENCE
Habitat	Moist riparian habitats with shrubby vegetation at Rocky Flats Plant	Stoecker (1992)
Body Weight	19 g (before fattening for hibernation)	Morrison and Ryser (1962)
Diet Composition	Seeds, fruit, insects, and fungi. In spring, diet is 20% seeds and 50% animal material; as season progresses, more seeds are eaten; grass seeds are the dietary mainstay.	Whitaker (1972)
Food Ingestion Rate	Daily ingestion rate of dry matter = .621 (body mass in grams)$^{.564}$	Nagy (1987)
Water Ingestion Rate	99 (body mass in kilograms)$^{.9}$	Calder and Braun (1983)
Home Range Size	0.08 to 0.35 ha in Minnesota	Quimby (1951)
Population Density	48 animals/ha and 7.4-14.4 animals/ha at two Minnesota sites, with considerable variation	Quimby (1951)

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ATTACHMENT E-2

ECOLOGICAL COMMUNITY DATA

E-2-1: Cover Transect Summary Forms
E-2-2: Production Plot Summary Forms
E-2-3: Benthic Invertebrate Data

E-2-1: Cover Transect Summary Forms

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Mesic Grassland, Study, Final 1991

Study Site	BG01A	BG01A	MG01A	MG01A	MG02A	MG02A	MG03A	MG03A	MG04A	MG04A		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s)	21-Aug	21-Aug	21-Aug	21-Aug	22-Aug	22-Aug	22-Aug	22-Aug	22-Aug	22-Aug	mean	stdev
TREE CANOPY												
Total Trees	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Total Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER												
(1) Rock	2	1	7	2	2	5	6	3	5	1	3.4	2.06
(2) Bare Soil	4	1	1	6	1	1	0	1	2	1	1.8	1.72
(3) Litter	61	64	50	63	68	61	65	73	72	76	65.3	7.1
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti												
Opuntia polyacantha	0	0	0	0	1	0	1	0	0	0	0.2	0.4
(6) Graminoids												
Agropyron smithii	7	6	16	14	2	4	4	9	11	14	8.7	4.63
Andropogon gerardii	0	0	0	0	0	0	0	0	2	0	0.2	0.6
Aristida p. robusta	4	0	0	0	0	0	0	0	0	0	0.4	1.2
Bouteloua curtipendula	2	5	0	1	2	0	0	0	2	0	1.2	1.54
Bouteloua gracilis	6	9	2	2	7	9	9	3	1	5	5.3	3
Bromus inermis	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Bromus japonicus	2	0	1	0	0	1	0	0	0	0	0.4	0.66
Bromus tectorum	3	1	5	0	1	0	1	1	3	0	1.5	1.57
Buchloe dactyloides	0	3	0	0	0	2	0	0	0	0	0.5	1.02
Carex eleocharis	1	3	1	0	0	3	5	2	1	0	1.6	1.56
Muhlenbergia torreyi	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Poa compressa	0	0	1	3	0	0	0	0	0	0	0.4	0.92
Poa pratensis	0	0	0	1	12	9	0	0	0	0	2.2	4.21
Sporobolus cryptandrus	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Sporobolus heterolepis	0	0	5	0	0	0	0	0	0	0	0.5	1.5
Stipa comata	0	0	1	0	0	0	0	0	0	0	0.1	0.3
Stipa viridula	0	0	3	1	0	0	0	0	0	0	0.4	0.92
(7) Forbs												
Allium textile	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Alyssum minus	2	0	0	0	0	0	1	1	0	0	0.4	0.66
Artemisia campestris	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Artemisia frigida	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Artemisia ludoviciana	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Aster falcatus	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Carduus nutans	0	2	0	0	2	0	0	0	0	1	0.5	0.81
Chrysopsis villosa	0	0	3	0	1	1	0	3	0	0	0.8	1.17
Cirsium arvense	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Cirsium undulatum	0	0	0	0	0	0	1	0	0	0	0.1	0.3

Erigeron divergens	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Erigeron flagellaris	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Erysimum asperum	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Euphorbia serpyllifolia	0	1	1	0	0	0	1	0	1	0	0.4	0.49
Gutierrezia sarothrae	0	0	1	0	0	1	0	0	0	0	0.2	0.4
Lactuca serriola	0	0	0	0	0	1	1	1	0	0	0.3	0.46
Lippia cuneifolia	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Potentilla gracilis	0	0	0	2	0	0	0	0	0	0	0.2	0.6
Sonchus a. arvensis	2	1	2	2	0	0	0	0	0	0	0.7	0.9
Sphaeralcea coccinea	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Taraxacum officinale	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Tragopogon dubius	0	0	0	0	0	1	0	0	0	0	0.1	0.3
TOTAL FORBS	7	5	7	7	4	5	4	8	1	1	4.9	2.34
TOTAL GRAMINOIDS	26	27	35	22	24	28	21	15	20	19	23.7	5.33
TOTAL CACTI	0	0	0	0	1	0	1	0	0	0	0.2	0.4
TOTAL PLANT GROUND COVER	33	32	42	29	29	33	26	23	21	20	28.8	6.32
TOTAL # OF PERRENIAL SP. HIT	25	28	35	28	25	30	22	20	17	19	24.9	5.26
TOTAL # OF ANNUAL/BIENNIAL SP. HI	8	4	7	1	4	3	4	3	4	1	3.9	2.12
TOTAL # OF NATIVE SP. HIT	24	27	33	23	14	20	22	20	18	19	22	4.98
TOTAL # INTRODUCED SP. HIT	9	5	9	6	15	13	4	3	3	1	6.8	4.35

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Mesic Grassland, Reference, 1991 Final

Study Site	BG01R	BG01R	MG01R	MG01R	MG02R	MG02R	MG03R	MG03R	MG04R	MG04R		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s)	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug	26-Aug	27-Aug	27-Aug	mean	stdev
TREE CANOPY												
Total Trees	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Total Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER												
(1) Rock	0	0	0	1	2	1	6	1	5	6	2.2	2.36
(2) Bare Soil	2	4	7	3	5	3	1	1	1	3	3	1.84
(3) Litter	59	57	54	59	59	61	51	56	70	52	57.8	5.11
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti												
Echinocereus viridiflorus	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Opuntia fragilis	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Opuntia polyacantha	0	0	1	2	0	0	3	2	1	0	0.9	1.04
(6) Graminoids												
Agropyron smithii	8	14	10	5	15	7	8	11	16	29	12.3	6.54
Andropogon gerardii	0	0	0	0	3	1	0	1	0	0	0.5	0.92
Aristida p. robusta	0	0	1	1	0	0	1	2	1	0	0.6	0.66
Bouteloua curtipendula	0	0	0	0	0	0	2	0	0	0	0.2	0.6
Bouteloua gracilis	10	13	14	9	4	5	8	6	3	3	7.5	3.77
Bromus inermis	0	0	0	0	0	0	0	3	0	0	0.3	0.9
Bromus japonicus	16	7	6	14	1	6	0	0	1	3	5.4	5.41
Bromus porteri	0	0	0	0	0	0	6	3	0	0	0.9	1.92
Bromus tectorum	1	0	2	0	3	0	0	0	1	0	0.7	1
Carex eleocharis	0	0	0	0	4	5	0	3	0	0	1.2	1.89
Muhlenbergia torreyi	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Poa compressa	0	0	0	0	0	0	3	0	0	0	0.3	0.9
Poa pratensis	0	2	0	0	0	0	5	4	0	0	1.1	1.81
Sitanion hystrix	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Sporobolus cryptandrus	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Stipa comata	0	0	0	0	1	0	0	0	0	0	0.1	0.3
(7) Forbs												
Achillea millefolium	0	3	0	0	0	0	0	1	0	0	0.4	0.92
Alyssum minus	0	0	0	0	0	0	3	1	0	1	0.5	0.92
Ambrosia psilostachya	0	0	0	0	1	3	0	0	0	0	0.4	0.92
Artemisia frigida	0	0	3	1	0	1	0	0	0	0	0.5	0.92
Artemisia ludoviciana	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Carduus nutans	3	0	1	2	0	0	0	0	0	0	0.6	1.02
Chenopodium leptophyllum	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Chrysopsis villosa	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Collomia linearis	0	0	0	0	0	0	0	0	0	1	0.1	0.3
Dalea purpurea	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Erigeron flagellaris	0	0	0	0	0	0	1	0	0	1	0.2	0.4
Eriogonum alatum	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Gutierrezia sarothrae	0	0	0	0	0	0	0	0	1	0	0.1	0.3
Hypericum perforatum	0	0	1	0	0	1	0	0	0	0	0.2	0.4

Lactuca serriola	0	0	0	0	1	4	0	0	0	1	0.6	1.2
Phacelia heterophylla	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Ratibida columnifera	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Verbascum thapsus	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Verbena bracteata	0	0	0	0	0	1	0	0	0	0	0.1	0.3
TOTAL FORBS	4	3	5	6	3	11	5	3	1	4	4.5	2.54
TOTAL GRAMINOIDS	35	36	33	29	31	24	34	35	22	35	31.4	4.67
TOTAL CACTI	0	0	1	2	0	0	3	4	1	0	1.1	1.37
TOTAL PLANT GROUND COVER	39	39	39	37	34	35	42	42	24	39	37	4.98
TOTAL # OF PERRENIAL SP. HITS	19	32	30	19	29	24	38	41	22	32	28.6	7.19
TOTAL # OF ANNUAL/BIENNIAL SP. HITS	20	7	9	18	5	11	4	1	2	7	8.4	6.04
TOTAL # OF NATIVE SP. HITS	19	30	29	20	29	24	31	34	22	34	27.2	5.27
TOTAL # OF INTRODUCED SP. HITS	20	9	10	17	5	11	11	8	2	5	9.8	5.19

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Xeric Grassland, Study, 1991 Final

Study Site	BX01A	BX01A	BX01A	BX01A	BX01A	MX01A	MX01A	MX01A	MX01A	MX01A		
Transect	1	2	3	4	5	1	2	3	4	5		
Date(s)	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	mean	stdev
TREE CANOPY												
Total Trees	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Total Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER												
(1) Rock	22	19	18	26	31	25	27	36	24	18	24.6	5.52
(2) Bare Soil	4	6	0	6	5	5	3	7	9	9	5.4	2.58
(3) Litter	57	53	59	51	40	51	52	40	44	57	50.4	6.55
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti	0	0	0	0	0	0	0	0	0	0	0	0
(6) Graminoids												
Agropyron cristatum	0	0	1	1	1	0	1	0	1	1	0.6	0.49
Agropyron repens	0	0	2	0	0	0	0	0	0	0	0.2	0.6
Andropogon scoparius	0	0	1	0	0	0	0	0	0	0	0.1	0.3
Aristida p. robusta	9	10	10	11	14	11	14	15	16	11	12.1	2.3
Bromus inermis	4	8	4	3	3	3	0	1	1	2	2.9	2.12
Bromus tectorum	3	3	1	1	4	4	0	0	1	2	1.9	1.45
Sporobolus cryptandrus	1	0	1	0	0	0	0	0	1	0	0.3	0.46
(7) Forbs												
Ambrosia psilostachya	0	0	0	0	0	0	0	0	1	0	0.1	0.3
Chrysopsis villosa	0	0	0	0	0	0	0	1	1	0	0.2	0.4
Convolvulus arvensis	0	0	0	1	1	0	0	0	0	0	0.2	0.4
Erodium cicutarium	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Grindelia squarrosa	0	1	1	0	1	0	2	0	0	0	0.5	0.67
Salsola iberica	0	0	0	0	0	0	0	0	1	0	0.1	0.3
Taraxacum officinale	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Verbascum thapsus	0	0	2	0	0	0	0	0	0	0	0.2	0.6
TOTAL FORBS	0	1	3	1	2	1	3	1	3	0	1.5	1.12
TOTAL GRAMINOIDS	17	21	20	16	22	18	15	16	20	16	18.1	2.34
TOTAL PLANT GROUND COVER	17	22	23	17	24	19	18	17	23	16	19.6	2.91
TOTAL # OF PERENNIAL SP. HITS	14	18	19	16	19	15	15	17	21	14	16.8	2.27
TOTAL # OF ANNUAL/BIENNIAL SP. HITS	3	4	4	1	5	4	3	0	2	2	2.8	1.47
TOTAL # OF NATIVE SP. HITS	10	11	13	11	15	11	17	16	19	11	13.4	2.97
TOTAL # OF INTRODUCED SP. HITS	7	11	10	6	9	8	1	1	4	5	6.2	3.31

COVER TRANSECT SUMMARY FORM

HABITAT TYPE: Xeric Grassland, Reference, 1991 Final

Study Site	BX01R	BX01R	MX01R	MX01R	MX02R	MX02R	MX03R	MX03R	MX04R	MX04R		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s)	27-Aug	27-Aug	27-Aug	27-Aug	28-Aug	28-Aug	28-Aug	28-Aug	29-Aug	29-Aug	mean	stdev
TREE CANOPY												
Total Trees	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Total Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER												
(1) Rock	9	4	16	7	13	6	12	8	4	3	8.2	4.09
(2) Bare Soil	11	3	3	2	4	2	4	2	3	6	4	2.61
(3) Litter	50	63	52	56	54	53	53	53	58	58	55	3.61
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti												
Echinocereus viridiflorus	1	0	0	0	1	2	1	0	0	0	0.5	0.67
Mammilaria missouriensis	0	0	0	0	0	1	1	0	1	0	0.3	0.46
Opuntia polyacantha	1	1	1	0	5	2	0	0	3	0	1.3	1.55
(6) Graminoids												
Agropyron smithii	0	8	0	0	0	0	0	0	0	0	0.8	2.4
Andropogon gerardii	3	3	0	4	1	2	5	3	3	2	2.6	1.36
Andropogon scoparius	0	0	9	8	4	2	7	2	6	2	4	3.13
Aristida p. robusta	0	0	0	0	0	0	0	1	1	1	0.3	0.46
Bouteloua curtipendula	2	0	0	0	0	0	0	0	1	1	0.4	0.66
Bouteloua gracilis	4	2	1	0	3	3	1	2	3	8	2.7	2.1
Bromus japonicus	1	0	0	0	0	0	0	1	0	1	0.3	0.46
Bromus tectorum	0	0	0	0	0	0	3	1	0	0	0.4	0.92
Calamovilfa longifolia	0	0	0	2	0	0	0	0	0	0	0.2	0.6
Carex filifolia	1	1	0	0	0	1	0	0	0	0	0.3	0.46
Carex eleocharis	4	1	1	1	2	2	1	6	6	10	3.4	2.91
Koeleria pyramidata	5	0	0	0	4	1	4	3	0	0	1.7	1.95
Muhlenbergia montana	0	0	6	9	1	2	0	0	3	1	2.2	2.89
Poa compressa	1	0	2	1	2	5	1	1	0	0	1.3	1.42
Poa pratensis	0	0	0	0	1	1	0	0	0	0	0.2	0.4
Sitanion hystrix	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Stipa comata	1	1	0	0	0	0	0	2	0	0	0.4	0.66
(7) Forbs												
Alyssum minus	1	0	0	0	1	0	0	0	0	0	0.2	0.4
Ambrosia psilostachya	1	2	0	0	1	0	0	0	0	0	0.4	0.66
Arenaria fendleri	0	0	2	0	0	0	0	0	0	0	0.2	0.6
Artemisia dracunculus	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Artemisia frigida	0	2	0	0	0	1	1	2	0	2	0.8	0.87
Artemisia ludoviciana	0	1	0	0	1	5	0	0	0	1	0.8	1.47
Aster porteri	0	6	5	3	1	3	1	3	1	0	2.3	1.95
Chrysopsis fulcrata	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Chrysopsis villosa	1	0	0	0	0	0	2	3	0	0	0.6	1.02
Erigeron flagellaris	2	2	0	0	1	4	2	0	4	0	1.5	1.5
Eriogonum alatum	0	0	0	2	0	0	0	1	0	0	0.3	0.64
Helianthus pumilus	0	0	0	0	0	1	0	0	0	1	0.2	0.4
Hypericum perforatum	1	0	1	0	0	0	0	0	0	0	0.2	0.4

Liatris punctata	0	0	1	0	0	1	0	1	2	2	0.7	0.78
Oxytropis lambertii	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Paronychia jamesii	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Phacelia heterophylla	0	0	0	0	0	0	0	1	0	1	0.2	0.4
Solidago nemoralis	0	0	0	3	0	0	0	1	0	0	0.4	0.92
Vaccaria pyramidata	0	0	0	0	0	0	0	1	0	0	0.1	0.3
TOTAL FORBS	6	13	9	10	5	15	6	15	7	7	9.3	3.61
TOTAL GRAMINOIDS	22	16	19	25	18	19	23	22	23	26	21.3	3.03
TOTAL CACTI	2	1	1	0	6	5	2	0	4	0	2.1	2.07
TOTAL PLANT GROUND COVER	30	30	29	35	29	39	31	37	34	33	32.7	3.32
TOTAL # OF PERENNIAL SP. HITS	26	28	29	35	27	35	26	34	30	32	30.2	3.4
TOTAL # OF ANNUAL/BIENNIAL SP.	4	2	0	0	2	4	5	3	4	1	2.5	1.69
TOTAL # OF NATIVE SP. HITS	26	30	26	34	25	33	27	33	34	32	30	3.46
TOTAL # OF INTRODUCED SP. HITS	4	0	3	1	4	6	4	4	0	1	2.7	1.95

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Marshland, Study, 1991 Final

Study Site	BA01A	BA01A	BA01A	MA01A	MA01A	MA01A	MA02A	MA02A	MA02A	MA03A	MA03A	MA03A	MA04A	MA04A	MA04A		
Transect	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
Date(s)	6-Sep	06-Sep	19-Sep	06-Sep	06-Sep	19-Sep	06-Sep	06-Sep	20-Sep	06-Sep	06-Sep	19-Sep	06-Sep	06-Sep	19-Sep	mean	stdev
TREE CANOPY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tree Canopy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Shrub Canopy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER																	
(1) Rock	0	10	0	3	0	4	1	0	0	0	0	0	1	0	0	1.27	2.62
(2) Bare Soil	24	20	23	6	0	3	13	19	18	48	40	25	5	11	11	17.73	12.87
(3) Litter	57	52	60	69	75	73	68	73	66	47	52	59	83	75	71	65.33	10
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(6) Graminoids																	
Agropyron smithii	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0.2	0.75
Bromus japonicus	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0.2	0.76
Hordeum jubatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.4	1.5
Phleum pratense	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0.07	0.25
Poa compressa	0	0	0	20	22	13	0	0	0	0	0	1	0	0	0	3.73	7.51
Poa pratensis	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0.13	0.5
Polypogon monspeliensis	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0.4	1.5
Typha angustifolia	9	10	6	0	0	0	10	5	7	6	4	8	0	2	0	4.47	3.76
Typha latifolia	8	8	10	0	0	0	8	3	9	9	4	7	0	1	6	4.87	3.74
(7) Forbs																	
Ambrosia psilostachya	0	0	0	0	1	0	0	0	0	0	0	0	3	2	3	0.6	1.08
Cirsium arvense	0	0	0	1	2	2	0	0	0	0	0	0	1	0	0	0.4	0.71
Conyza canadensis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.07	0.25
Oenothera flava	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0.2	0.54
Plantago major	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.07	0.25
Sonchus arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.07	0.25
Verbascum blattaria	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.07	0.25
Veronica americana	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.33	0.6
Veronica a.-aquatica	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.25
TOTAL FORBS	2	0	1	1	3	2	0	0	0	0	0	0	8	5	6	1.87	2.47
TOTAL GRAMINOIDS	17	18	16	21	22	18	18	8	16	15	8	16	3	9	12	14.47	5.18
TOTAL PLANT GROUND COVER	19	18	17	22	25	20	18	8	16	15	8	16	11	14	18	16.33	4.66
TOTAL PERRENIALS	19	18	17	22	25	20	18	8	16	15	8	16	6	14	18	16	5.09
TOTAL ANNUAL/BIENNIALS	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0.33	1.25
TOTAL NATIVE SP. HITS	19	18	17	0	1	3	18	8	16	15	8	15	5	14	17	11.6	6.5
TOTAL INTRODUCED SP. HITS	0	0	0	22	24	17	0	0	0	0	0	1	6	0	1	4.73	8.37

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Marshland, Reference, 1991 Final

Study Site	BA01R	BA01R	MA01R	MA01R	MA02R	MA02R	MA03R	MA03R	MA04R	MA04R		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s)	09-Sep	09-Sep	11-Sep	11-Sep	09-Sep	09-Sep	11-Sep	11-Sep	11-Sep	11-Sep	mean	stdev
TREE CANOPY	0	0	0	0	0	0	0	0	0	0	0	0
Total Tree Canopy	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Rosa acicularis	10	0	0	1	0	0	0	0	0	0	1.1	2.98
Symphoricarpos occidentalis	5	0	0	0	1	0	0	0	6	0	1.2	2.18
Total Shrub Canopy	15	0	0	1	1	0	0	0	6	0	2.3	4.58
GROUND COVER												
(1) Rock	1	0	0	0	0	0	0	2	0	0	0.3	0.64
(2) Bare Soil	0	0	1	2	0	0	2	3	0	0	0.8	1.08
(3) Litter	68	63	61	60	64	67	61	52	57	56	60.9	4.7
(4) Trees and Shrubs												
Rosa acicularis	1	0	0	0	0	0	0	0	0	0	0.1	0.3
(5) Cacti	0	0	0	0	0	0	0	0	0	0	0	0
(6) Graminoids												
Agropyron smithii	0	0	0	0	0	0	0	2	0	2	0.4	0.8
Agrostis hyemalis	0	1	0	0	0	1	0	0	0	0	0.2	0.4
Agrostis stolonifera	0	0	0	0	0	0	8	5	0	0	1.3	2.69
Andropogon scoparius	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Bromus japonicus	0	0	0	0	0	0	0	2	0	0	0.2	0.6
Bromus porteri	0	0	0	0	0	0	1	1	0	0	0.2	0.4
Carex lanuginosa	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Carex nebraskensis	6	1	2	5	3	5	0	3	2	1	2.8	1.89
Carex praegracilis	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Eleocharis coloradoensis	0	1	0	0	0	1	2	0	0	0	0.4	0.66
Eleocharis macrostachya	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Glyceria striata	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Juncus balticus	9	14	22	16	13	11	19	21	34	30	18.9	7.7
Muhlenbergia racemosa	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Poa compressa	1	0	0	0	1	0	0	1	0	0	0.3	0.46
Poa pratensis	1	2	0	0	0	0	0	1	2	0	0.6	0.8
Scirpus pallidus	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Spartina pectinata	0	0	0	6	0	0	0	0	0	1	0.7	1.79
Typha latifolia	2	0	2		2	3	0	0	0	0	1	1.15
(7) Forbs												
Achillea millefolium	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Artemisia ludoviciana	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Barbarea orthoceras	0	10	3	1	7	3	0	0	2	0	2.6	3.23
Cirsium arvense	1	0	6	5	1	3	2	2	2	4	2.6	1.8
Galium aparine	0	0	1	2	0	0	1	0	0	0	0.4	0.66
Glycyrrhiza lepidota	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Lomatium orientale	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Medicago lupulina	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Mentha arvensis	0	2	0	0	3	1	0	2	0	2	1	1.1
Oenothera flava	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Polygonum amphibium	0	0	0	2	0	0	0	0	0	0	0.2	0.6

Ranunculus macounii	1	0	1	0	3	1	0	0	0	0	0.6	0.92
Rumex obtusifolia	1	2	0	0	1	0	0	0	0	0	0.4	0.66
Solidago mollis	0	0	0	0	0	0	0	0	0	1	0.1	0.3
Sonchus a. uliginosus	0	0	0	0	0	0	0	0	0	2	0.2	0.6
Lycopus americana	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Taraxacum officinale	1	0	0	0	0	0	0	0	0	0	0.1	0.3
Veronica a.-aquatica	0	0	0	0	0	0	1	0	0	0	0.1	0.3
Viola nephrophylla	5	0	1	1	0	4	0	0	1	1	1.3	1.68
TOTAL FORBS	11	15	12	11	16	12	6	5	5	10	10.3	3.69
TOTAL GRAMINOIDS	19	22	26	27	20	21	31	38	38	34	27.6	6.92
TOTAL TREES AND SHRUBS	1	0	0	0	0	0	0	0	0	0	0.1	0.3
TOTAL PLANT GROUND COVER	31	37	38	38	36	33	37	43	43	44	38	4.07
TOTAL PERRENIAL SP. HITS	29	35	37	38	32	32	37	40	43	42	36.5	4.32
TOTAL ANNUAL/BIENNIAL SP. HITS	2	2	1	0	4	1	0	3	0	2	1.5	1.28
TOTAL NATIVE SP. HITS	27	33	32	33	31	29	35	34	39	36	32.9	3.27
TOTAL INTRODUCED SP. HITS	4	4	6	5	5	4	2	9	4	8	5.1	1.97

COVER TRANSECT SUMMARY FORM

HABITAT TYPE: Riparian, Study, 1991 Final

Study Site	BW01A	BW01A	BW01A	MW01A	MW01A	MW01A	MW02A	MW02A	MW02A	MW03A	MW03A	MW03A	MW04A	MW04A	MW04A		
Transect	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
Date(s)	29-Aug	29-Aug	12-Sep	23-Aug	23-Aug	12-Sep	03-Sep	03-Sep	16-Sep	03-Sep	03-Sep	16-Sep	03-Sep	03-Sep	18-Sep	mean	stdev
TREE CANOPY																	
Populus alba	0	0	0	0	0	0	27	5	8	0	0	0	0	0	0	2.5	6.89
Populus angustifolia	0	0	0	0	0	0	0	0	0	29	15	0	0	0	0	2.75	7.9
Populus deltiodes	9	13	14	20	12	11	6	7	23	22	5	11	0	22	11	11.63	6.6
Salix amygdaloides	4	0	0	0	0	0	0	0	0	23	25	0	0	0	0	3.25	8.12
Total Tree Canopy	13	13	14	20	12	11	33	12	31	74	45	11	0	22	11	20.13	17.72
SHRUB CANOPY																	
Amorpha fruticosa	35	28	27	0	0	0	12	35	30	10	12	4	50	21	30	18.38	14.93
Populus alba	0	0	0	0	0	0	7	6	1	0	0	0	0	0	0	0.88	2.21
Populus angustifolia	0	0	0	0	0	0	0	0	0	2	9	0	0	0	0	0.69	2.26
Populus deltiodes	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	1
Prunus virginiana	0	18	14	0	0	0	0	0	0	0	0	0	0	0	0	2	5.49
Rosa acicularis	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0.25	0.57
Salix amygdaloides	0	0	0	0	0	0	0	0	3	7	3	0	0	0	0	0.81	1.93
Salix exigua	32	8	6	30	38	38	0	22	24	19	45	28	12	15	0	19.81	13.69
Symphoricarpos occidentalis	3	0	0	0	0	0	1	1	0	0	2	2	3	0	0	0.75	1.11
Total Shrub Canopy	76	54	48	30	38	38	20	65	58	38	71	34	65	36	30	43.81	16.48
GROUND COVER																	
(1) Rock	9	9	5	0	3	1	27	18	6	31	14	1	7	14	7	9.5	8.94
(2) Bare Soil	5	4	1	14	14	3	5	7	2	6	0	1	8	10	2	5.13	4.3
(3) Litter	57	62	73	70	58	75	44	49	66	44	78	75	58	48	70	57.94	11.34
(4) Trees and Shrubs																	
Amorpha fruticosa	0	2	1	0	0	0	0	0	1	0	0	0	4	1	0	0.56	1.08
Populus alba	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.06	0.25
Populus deltoides	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0.25	0.44
Prunus virginiana	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	1
Rosa acicularis	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0.13	0.34
Salix amygdaloides	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0.19	0.54
Salix exigua	5	1	0	1	2	6	1	1	0	6	5	1	1	0	0	1.88	2.19
Symphoricarpos occidentalis	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0.13	0.34
(5) Cacti																	
Opuntia polyacantha	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.06	0.25
(6) Graminoids																	
Agropyron repens	2	3	0	0	0	0	0	0	0	2	0	3	2	3	3	1.13	1.33
Agropyron smithii	0	2	2	0	0	0	3	1	0	0	0	1	0	1	3	0.81	1.09
Andropogon gerardii	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0.13	0.5
Bouteloua gracilis	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0.5	2
Bromus inermis	0	0	0	12	19	13	0	0	0	0	0	0	0	0	0	2.75	6.03
Bromus japonicus	0	0	1	0	0	0	1	0	0	0	0	5	1	2	0	0.63	1.3
Bromus tectorum	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5	0.69	1.88
Calamagrostis canadensis	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0.19	0.54
Carex nebraskensis	0	0	0	0	0	0	2	4	4	0	0	0	0	0	0	0.63	1.4
Carex praegracilis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.25
Carex eleocharis	0	0	0	0	0	0	3	2	0	0	0	0	0	2	0	0.44	0.96
Elymus canadensis	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0.13	0.5

Glyceria grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0.13	0.5
Juncus balticus	1	1	2	0	0	0	0	5	3	0	0	0	0	0	0	0.75	1.42
Muhlenbergia racemosa	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0.06	0.25
Panicum virgatum	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0.06	0.25
Poa compressa	5	9	8	2	2	0	0	0	0	0	0	3	6	10	5	3.13	3.48
Poa pratensis	8	0	3	0	0	0	2	4	11	9	0	8	5	2	0	3.25	3.72
Scirpus pallidus	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0.19	0.4
Typha latifolia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.13	0.34
(7) Forbs																	
Ambrosia psilostachya	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0.13	0.34
Artemisia ludoviciana	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0.19	0.4
Asclepias speciosa	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0.19	0.54
Aster falcatus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.25
Carduus nutans	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.06	0.25
Cirsium arvense	1	0	0	1	0	2	0	0	1	1	1	1	0	0	1	0.56	0.61
Equisetum arvense	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.06	0.25
Grindelia squarrosa	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0.19	0.4
Melilotus officinalis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.06	0.25
Mentha arvensis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0.06	0.25
Nepeta cataria	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.13	0.34
Oxalis dillenii	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.06	0.25
Potentilla hippiana	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.34
Solidago missouriensis	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0.19	0.4
Solidago mollis	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.19	0.54
Verbascum blattaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25
TOTAL FORBS	6	3	2	1	0	2	3	4	3	1	1	3	1	4	3	2.31	1.5
TOTAL GRAMINOIDS	16	15	18	14	21	13	22	18	22	11	0	20	21	22	19	15.75	5.64
TOTAL TREES AND SHRUBS	7	7	1	1	2	6	3	4	1	7	7	1	5	2	1	3.44	2.49
TOTAL CACTI	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.06	0.25
TOTAL PLANT GROUND COVER	29	25	21	16	23	21	29	26	26	19	8	24	27	28	23	21.56	5.38
TOTAL # OF PERENNIAL SP. HITS	29	25	20	16	23	21	26	25	26	19	8	19	20	23	17	19.81	4.99
TOTAL # OF ANNUAL/BIENNIAL SP	0	0	1	0	0	0	3	1	0	0	0	5	7	5	5	1.69	2.4
TOTAL # OF NATIVE SP. HITS	13	13	9	1	2	6	26	22	13	7	7	4	7	9	8	9.19	6.62
TOTAL # OF INTRODUCED SP. HIT	16	12	12	15	21	15	3	4	13	12	1	20	20	19	14	12.31	6.02

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Riparian, Reference, 1991 Final

Study Site	BW01R	BW01R	MW01R	MW01R	MW02R	MW02	MW03R	MW03R	MW04R	MW04R		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s)	04-Sep	04-Sep	04-Sep	04-Sep	04-Sep	04-Sep	05-Sep	05-Sep	04-Sep	04-Sep	mean	stdev
TREE CANOPY												
Populus angustifolia	0	0	0	0	0	4	0	0	0	0	0.4	1.2
Populus deltiodes	5	1	24	3	23	11	16	18	7	0	10.8	8.51
Populus deltiodes (hybrid)	0	0	0	0	0	0	0	0	0	3	0.3	0.9
Ulmus pumila	0	0	0	0	0	0	0	0	0	12	1.2	3.6
Total Tree Canopy	5	1	24	3	23	15	16	18	7	15	12.7	7.79
SHRUB CANOPY												
Amorpha fruticosa	16	19	43	10	65	34	38	50	36	38	34.9	15.66
Humulus lupulus	0	0	1	0	0	0	0	0	0	0	0.1	0.3
Populus deltiodes	0	1	5	3	3	1	1	0	6	2	2.2	1.94
Prunus virginiana	0	0	0	3	0	0	0	1	0	0	0.4	0.92
Rhus aromatica	0	0	0	5	0	0	0	0	0	0	0.5	1.5
Rosa acicularis	4	0	0	0	2	0	0	0	0	0	0.6	1.28
Salix amygdaloides	0	0	0	0	2	1	0	2	0	0	0.5	0.81
Salix exigua	0	11	13	22	0	5	3	14	8	0	7.6	7
Symphoricarpos occidentalis	0	0	0	2	0	0	0	0	0	0	0.2	0.6
Ulmus pumila	0	0	0	0	0	0	0	0	0	1	0.1	0.3
Total Shrub Canopy	20	31	62	45	72	41	42	67	50	41	47.1	15.31
GROUND COVER												
(1) Rock	31	20	6	3	6	11	38	14	20	22	17.1	10.78
(2) Bare Soil	7	7	5	2	0	7	4	12	1	6	5.1	3.36
(3) Litter	35	51	64	65	63	49	32	41	51	46	49.7	11.13
(4) Trees and Shrubs												
Amorpha fruticosa	0	0	0	0	2	0	0	1	0	2	0.5	0.81
Populus deltiodes	0	0	0	0	0	1	0	0	1	0	0.2	0.4
Prunus virginiana	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Rosa acicularis	1	0	0	1	0	0	0	0	0	0	0.2	0.4
Salix exigua	0	1	0	0	0	0	0	0	2	0	0.3	0.64
Symphoricarpos occidentalis	0	0	0	1	0	1	0	0	0	0	0.2	0.4
(5) Cacti												
Opuntia polyacantha	1	0	0	3	0	1	0	1	0	0	0.6	0.92
(6) Graminoids												
Agropyron repens	1	2	3	0	1	2	0	0	0	1	1	1
Agropyron smithii	0	0	1	3	1	6	2	2	1	0	1.6	1.74
Aristida p. robusta	4	1	0	0	0	0	0	0	2	1	0.8	1.25
Bouteloua gracilis	6	0	0	3	0	1	0	0	1	0	1.1	1.87
Bromus inermis	0	0	0	0	0	0	1	1	0	0	0.2	0.4
Bromus japonicus	1	5	1	2	2	4	1	0	2	0	1.8	1.54
Bromus porteri	0	0	0	0	0	0	3	2	2	1	0.8	1.08
Bromus tectorum	2	0	1	0	3	2	7	0	4	3	2.2	2.09
Carex nebraskensis	0	0	0	0	3	1	1	5	0	0	1	1.61
Dactylis glomerata	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Juncus balticus	0	0	4	5	6	2	0	9	0	0	2.6	3.07
Juncus dudleyi	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Muhlenbergia racemosa	0	1	0	0	2	2	0	0	0	2	0.7	0.9

Phleum pratense	0	0	1	0	0	0	0	0	0	0	0.1	0.3
Poa compressa	6	6	7	2	1	3	2	0	8	11	4.6	3.35
Poa pratensis	0	0	3	1	2	0	6	0	1	1	1.4	1.8
Sitanion hystrix	0	1	0	0	0	0	0	0	1	0	0.2	0.4
Sporobolus cryptandrus	2	0	0	2	1	0	0	0	1	0	0.6	0.8
Stipa comata	0	1	0	0	0	0	1	0	0	0	0.2	0.4
(7) Forbs												
Achillea millefolium	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Alyssum minus	1	0	0	2	0	0	0	0	0	2	0.5	0.81
Ambrosia psilostachya	0	0	0	0	0	0	0	0	1	0	0.1	0.3
Artemisia frigida	0	1	0	0	0	0	0	1	1	0	0.3	0.46
Carduus nutans	0	0	0	0	0	0	0	1	0	1	0.2	0.4
Chrysopsis villosa	1	0	0	0	0	0	1	0	0	0	0.2	0.4
Cirsium arvense	0	0	0	1	0	0	0	1	0	0	0.2	0.4
Conyza canadensis	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Erigeron flagellaris	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Geranium caespitosum	0	1	1	1	2	1	1	3	0	0	1	0.89
Grindelia squarrosa	0	0	1	0	0	0	0	0	0	0	0.1	0.3
Lactuca serriola	0	0	0	1	0	0	0	0	0	0	0.1	0.3
Lycopus americana	0	0	0	0	1	0	0	2	0	0	0.3	0.64
Polygonum convolvulus	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Solidago missouriensis	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Solidago mollis	1	0	1	1	0	0	0	0	0	0	0.3	0.46
Thermopsis divaricarpa	0	0	0	0	0	1	0	1	0	1	0.3	0.46
Verbascum blattaria	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Verbascum thapsus	0	1	0	0	0	0	0	0	0	0	0.1	0.3
Viola nephrophylla	0	0	1	0	1	0	0	0	0	0	0.2	0.4
TOTAL FORBS	3	4	4	6	4	7	2	9	2	4	4.5	2.11
TOTAL GRAMINOIDS	22	17	21	18	23	23	24	20	23	20	21.1	2.21
TOTAL TREES AND SHRUBS	1	1	0	3	2	2	0	1	3	2	1.5	1.02
TOTAL CACTI	1	0	0	3	0	1	0	1	0	0	0.6	0.92
TOTAL PLANT GROUND COVER	27	22	25	30	29	33	26	31	28	26	27.7	3.03
TOTAL # OF PERRENIAL SP. HITS	23	15	22	25	24	24	18	30	22	20	22.3	3.87
TOTAL # OF ANNUAL/BIENNIAL SP. HIT	4	7	3	5	5	9	8	1	6	6	5.4	2.24
TOTAL # OF NATIVE SP. HITS	16	8	10	21	20	20	9	28	13	7	15.2	6.58
TOTAL # OF INTRODUCED SP. HITS	11	14	15	9	9	13	17	3	15	19	12.5	4.41

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Reclaimed Grassland, Study, Final 1991

Study Site	BR02A	BR02A	MR01A	MR01A	MR02A	MR02A	MR03A	MR03A	MR04A	MR04A		
Transect	1	2	1	2	1	2	1	2	1	2		
Date(s) 1991	20-Aug	20-Aug	21-Aug	21-Aug	21-Aug	21-Aug	20-Aug	20-Aug	20-Aug	20-Aug	mean	stdev
TREE CANOPY												
Total Trees	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY												
Total Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER												
(1) Rock	0	1	3	1	4	11	6	2	0	0	2.8	3.31
(2) Bare Soil	11	12	3	3	3	4	0	3	5	8	5.2	3.68
(3) Litter	69	72	71	71	70	66	82	78	73	70	72.2	4.38
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti	0	0	0	0	0	0	0	0	0	0	0	0
(6) Graminoids												
Agropyron cristatum	0	0	4	0	1	3	0	0	1	0	0.9	1.37
Agropyron intermedium	0	0	4	3	3	13	0	0	0	0	2.3	3.87
Agropyron repens	0	0	0	0	1	0	0	0	0	0	0.1	0.3
Agropyron smithii	0	0	5	3	4	0	0	0	0	0	1.2	1.89
Andropogon gerardii	3	0	0	0	0	0	0	0	2	3	0.8	1.25
Andropogon scoparius	8	1	0	0	0	0	0	0	4	4	1.7	2.61
Aristida p. longiseta	0	0	0	0	0	0	0	0	1	1	0.2	0.4
Aristida p. robusta	0	3	0	0	0	0	0	0	1	1	0.5	0.92
Bromus inermis	8	9	6	14	7	0	12	16	11	11	9.4	4.29
Bromus japonicus	1	2	0	0	0	0	0	0	0	0	0.3	0.64
Bromus tectorum	0	0	0	0	0	0	0	0	1	0	0.1	0.3
Panicum capillare	0	0	0	0	0	0	0	0	0	1	0.1	0.3
Phleum pratense	0	0	0	2	0	0	0	0	0	0	0.2	0.6
Poa compressa	0	0	0	1	2	1	0	0	0	0	0.4	0.66
Poa pratensis	0	0	0	0	2	0	0	0	0	0	0.2	0.6
(7) Forbs												
Artemisia ludoviciana	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Cirsium arvense	0	0	0	0	0	1	0	0	0	0	0.1	0.3
Convolvulus arvensis	0	0	0	0	0	0	0	1	0	0	0.1	0.3
Lactuca serriola	0	0	0	0	0	0	0	0	0	1	0.1	0.3
Melilotus officinalis	0	0	4	2	2	0	0	0	1	0	0.9	1.3
Verbascum thapsus	0	0	0	0	0	1	0	0	0	0	0.1	0.3
TOTAL FORBS	0	0	4	2	2	3	0	1	1	1	1.4	1.28
TOTAL GRAMINOIDS	20	15	19	23	20	17	12	16	21	21	18.4	3.17
TOTAL PLANT GROUND COVER	20	15	23	25	22	20	12	17	22	22	19.8	3.79
TOTAL # OF PERRENIAL SP. HITS	19	13	19	23	20	19	12	17	20	20	18.2	3.19
TOTAL # OF ANNUAL/BIENNIAL SP. HIT	1	2	4	2	2	1	0	0	2	2	1.6	1.11
TOTAL # OF NATIVE SP. HITS	11	4	5	3	4	1	0	0	8	10	4.6	3.75
TOTAL # OF INTRODUCED SP. HITS	9	11	18	22	18	19	12	17	14	12	15.2	3.97

COVER TRANSECT SUMMARY FORM
HABITAT TYPE: Disturbed Land, Study, 1991 Final

Study Site	BD01A	BD01A	BD01A	BD01A	BD01A	BD01A	BD01A	MD01A	MD01A	MD01A	MD01A	MD01A	MD02A	MD02A	MD02A		
Transect	1	2	3	4	5	6	7	1	2	3	4	5	1	2	3		
Date(s)	12-Sep	12-Sep	12-Sep	12-Sep	23-Sep	23-Sep	23-Sep	12-Sep	12-Sep	12-Sep	24-Sep	24-Sep	12-Sep	12-Sep	12-Sep	mean	stdev
TREE CANOPY																	
Total Tree Canopy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHRUB CANOPY																	
Total Shrub Canopy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GROUND COVER																	
(1) Rock	20	0	0	0	16	0	0	0	0	0	0	0	15	31	18	6.67	10
(2) Bare Soil	31	19	24	51	26	24	22	36	40	41	42	45	19	20	23	30.87	10.33
(3) Litter	39	60	53	38	44	58	61	46	44	43	43	49	55	37	48	47.87	7.64
(4) Trees and Shrubs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Cacti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(6) Graminoids																	
Agropyron cristatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.07	0.25
Agropyron repens	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0.27	0.57
Bromus inermis	3	2	2	1	4	2	1	2	8	2	4	6	8	6	4	3.67	2.27
Bromus japonicus	0	3	6	4	2	4	5	4	2	2	3	2	0	0	0	2.47	1.86
Bromus tectorum	0	6	6	0	2	5	7	5	2	8	3	4	0	0	0	3.2	2.76
Hordeum jubatum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.07	0.25
Panicum capillare	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.07	0.25
Setaria viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.07	0.25
Sporobolus cryptandrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.07	0.25
(7) Forbs																	
Alyssum minus	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0.2	0.4
Ambrosia psilostachya	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0.2	0.4
Bidens cernua	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.25
Carduus nutans	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.07	0.25
Centaurea diffusa	1	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0.33	0.6
Centaurea repens	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0.2	0.4
Cirsium arvense	0	2	1	0	0	2	1	1	0	1	0	0	0	0	0	0.53	0.72
Convolvulus arvensis	1	1	0	0	0	1	1	0	1	0	0	0	2	2	0	0.6	0.71
Cynoglossum officinale	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.25
Dyssodia papposa	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0.2	0.54
Grindelia squarrosa	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.13	0.34
Helianthus annuus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.07	0.25
Lactuca serriola	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0.07	0.25
Melilotus alba	0	0	5	0	0	0	0	0	0	0	1	0	0	0	0	0.4	1.25
Melilotus officinalis	5	1	0	5	3	1	0	5	2	1	1	2	1	2	1	2	1.67
TOTAL FORBS	7	10	9	6	4	7	4	6	3	3	4	3	3	4	4	5.13	2.19
TOTAL GRAMINOIDS	3	11	14	5	10	11	13	11	12	12	11	13	8	8	7	9.93	3.02
TOTAL PLANT GROUND COVER	10	21	23	11	14	18	17	17	15	15	15	16	11	12	11	15.07	3.66
TOTAL # OF PERENNIAL SP. HITS	4	7	4	2	5	6	3	3	9	3	6	7	10	10	6	5.67	2.49
TOTAL # OF ANNUAL/BIENNIAL SP	6	14	19	9	9	12	14	14	6	12	9	9	1	2	5	9.4	4.74
TOTAL # OF NATIVE SP. HITS	0	3	0	0	3	1	1	0	0	0	1	0	0	0	6	1	1.67
TOTAL # OF INTRODUCED SP. HIT	10	18	23	11	11	17	16	17	15	15	14	16	11	12	5	14.07	4.11

E-2-2: Production Plot Summary Forms

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Study, 1991 (PRODGA91)

Study Site	MG01A	MG01A	MG01A	MG01A	MG01A	MG01A	MG01A	MG01A	MG01A	MG01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	0.0	0.0	4.6	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.65	1.43
Agropyron smithii	19.8	47.1	0.0	0.0	44.9	54.8	12.3	28.0	27.3	26.0	26.02	17.93
Aristida p. robusta	0.0	0.0	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.09	6.27
Bouteloua curtipendula	0.0	0.0	0.0	22.1	0.0	0.0	0.0	0.0	0.0	0.0	2.21	6.63
Bouteloua gracilis	1.7	0.0	3.0	0.0	0.0	4.1	0.0	0.0	5.8	13.7	2.83	4.12
Bromus inermis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.74	2.22
Bromus japonicus	0.5	3.6	1.9	0.0	0.0	0.0	2.0	0.7	0.0	0.7	0.94	1.14
Bromus tectorum	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.11	0.17
Buchloe dactyloides	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.24	0.6
Carex stenophylla	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.21
Koeleria pyramidata	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.33	0.99
Muhlenbergia montana	0.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.61	1.83
Poa pratensis	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.54	1.62
Sporobolus heterolepus	0.0	0.0	0.0	0.0	0.0	0.0	9.9	0.0	0.0	0.0	0.99	2.97
Stipa viridula	0.0	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.82	2.4[illegible]
Subtotal, Graminoids	22.0	51.7	50.0	29.4	44.9	58.9	24.2	36.5	33.5	40.8	39.19	11.63
FORBS												
Agoseris sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.04	0.12
Alyssum minus	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.0	0.0	0.35	0.62
Aster falcatus	0.0	0.0	7.3	0.0	0.0	0.0	4.0	0.0	6.6	0.0	1.79	2.84
Aster sp.	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Carduus nutans	0.9	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15	0.28
Cirsium arvense	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.11	0.33
Euphorbia serpyllifolia	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.03	0.09
Gutierrezia sarothrae	56.6	0.0	0.0	0.0	0.5	0.0	1.1	0.0	0.0	0.0	5.82	16.93
Hypericum perforatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.3
Lactuca serriola	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.9	0.0	0.0	0.14	0.29
Melilotus officinalis	2.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.25	0.6
Unidentified legume	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.1
Verbascum blattaria	1.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.24	0.57
Subtotal, Forbs	62.1	1.1	7.6	8.1	1.5	0.0	5.8	1.7	8.6	1.0	9.75	17.73
TOTAL SPECIES	28	28	28	28	28	28	28	28	28	28	28	0
TOTAL WEIGHT	84.1	52.8	57.6	37.5	46.4	58.9	30.0	38.2	42.1	41.8	48.94	14.61
GRAMS/SQUARE METER	336.4	211.2	230.4	150.0	185.6	235.6	120.0	152.8	168.4	167.2	195.76	58.44
KILOGRAMS/HECTARE	3364.0	2112.0	2304.0	1500.0	1856.0	2356.0	1200.0	1528.0	1684.0	1672.0	1957.6	584.39
POUNDS/ACRE	3001.4	1884.3	2055.6	1338.3	1655.9	2102.0	1070.6	1363.3	1502.5	1491.8	1746.57	521.4

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Study, 1991 (PRODGA91)

Study Site	MG02A	MG02A	MG02A	MG02A	MG02A	MG02A	MG02A	MG02A	MG02A	MG02A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	26-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	27.4	11.3	0.6	14.2	10.2	5.9	8.8	7.5	2.6	1.9	9.04	7.39
Bouteloua gracilis	0.0	0.4	13.2	0.9	0.0	8.9	0.0	2.9	1.5	3.2	3.1	4.23
Bromus japonicus	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.4	0.0	0.0	0.09	0.14
Buchloe dactyloides	0.0	0.0	2.0	0.0	0.2	7.0	0.0		0.0	0.0	1.02	2.2
Poa pratensis	0.0	17.3	3.1	1.4	0.0	0.0	16.0	0.0	14.2	1.9	5.39	6.94
Subtotal, Graminoids	27.4	29.0	19.2	16.7	10.4	21.8	24.8	10.8	18.3	7.0	18.54	7.08
FORBS												
Achillea millefolium	0.0	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.01	3.03
Agoseris sp.	0.0	0.0	0.3	0.0	0.2	0.4	0.0	0.3	1.9	0.0	0.31	0.55
Alyssum minus	0.2	0.0	0.9	0.5	0.8	1.2	0.3	1.6	0.3	0.0	0.58	0.51
Artemisia ludoviciana	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Aster porteri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.95	2.85
Carduus nutans	0.9	0.0	0.5	0.5	1.5	1.6	2.2	15.1	8.8	0.0	3.11	4.69
Grindelia squarrosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.03	0.09
Helianthus annuus	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.89	2.67
Hypericum perforatum	0.0	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11	0.25
Lactuca serriola	0.0	0.0	3.7	1.5	0.0	0.4	0.0	0.0	0.3	0.0	0.59	1.13
Liatris punctata	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6
Linaria dalmatica	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.67	2.01
Miscellaneous small forbs	0.0	0.0	0.2	0.2	0.4	0.0	0.2	0.0	0.0	0.0	0.1	0.13
Ratibida columnaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.24	0.72
Sphaelera coccinea	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.05	0.15
Tragopogon dubius	0.0	0.0	0.0	3.9	1.3	0.0	0.0	1.2	2.2	0.0	0.86	1.26
Verbascum blattaria	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2
Verbascum thapsus	0.0	0.0	0.0	45.2	0.0	0.0	0.0	0.0	0.2	0.0	4.54	13.55
Subtotal, Forbs	10.0	14.9	6.3	52.3	12.9	3.6	2.7	28.0	16.1	0.0	14.68	14.74
TOTAL SPECIES	18	18	18	18	18	18	18	18	18	18	18	0
TOTAL WEIGHT	37.4	43.9	25.5	69.0	23.3	25.4	27.5	38.8	34.4	7.0	33.22	15.44
GRAMS/SQUARE METER	149.6	175.6	102.0	276.0	93.2	101.6	110.0	155.2	137.6	28.0	132.88	61.76
KILOGRAMS/HECTARE	1496.0	1756.0	1020.0	2760.0	932.0	1016.0	1100.0	1552.0	1376.0	280.0	1328.8	617.56
POUNDS/ACRE	1334.7	1566.7	910.0	2462.5	831.5	906.5	981.4	1384.7	1227.7	249.8	1185.56	550.99

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Study, 1991 (PRODGA91)

Study Site	MG03A	MG03A	MG03A	MG03A	MG03A	MG03A	MG03A	MG03A	MG03A	MG03A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	06-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	0.0	0.0	0.0	0.0	6.7	0.0	6.5	0.9	13.5	15.4	4.3	5.68
Aristida p. robusta	0.0	0.0	0.0	0.0	26.5	0.0	0.0	0.0	8.0	11.2	4.57	8.26
Bouteloua curtipendula	6.4	0.3	4.7	0.5	4.5	12.3	8.7	15.7	14.4	9.4	7.69	5.11
Bouteloua gracilis	5.3	0.7	2.4	21.6	0.0	0.6	0.0	0.0	0.0	8.1	3.87	6.46
Bromus inermis	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.62	1.86
Bromus japonicus	0.2	0.7	0.9	0.4	0.5	4.6	0.4	1.1	7.2	0.0	1.6	2.25
Bromus tectorum	0.0	0.3	0.0	0.0	0.0	0.4	0.2	0.5	0.0	0.0	0.14	0.19
Buchloe dactyloides	0.4	0.0	0.0	3.2	1.2	0.0	0.0	0.0	0.0	0.0	0.48	0.98
Koeleria pyramidata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	11.1	1.84	3.78
Subtotal, Graminoids	18.5	2.0	8.0	25.7	39.4	17.9	15.8	18.2	50.4	55.2	25.11	16.75
FORBS												
Alyssum minus	0.6	8.3	0.9	2.5	1.7	0.5	0.2	0.0	7.2	0.0	2.19	2.89
Artemesia ludoviciana	0.0	0.0	0.0	0.0	6.8	0.0	42.1	5.7	0.0	6.9	6.15	12.33
Asclepias pumila	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.21
Carduus nutans	0.0	0.0	5.3	8.2	8.3	0.0	0.0	0.9	8.4	0.0	3.11	3.73
Chenopodium leptophyllum	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.03	0.09
Convolvulus arvensis	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9
Conyza canadensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.06	0.18
Dalea purpurea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	7.8	7.0	1.64	2.92
Dyssodia papposa	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.42
Euphorbia serpyllifolia	0.0	1.0	0.3	0.0	0.8	0.2	0.2	0	6.7	6.7	1.59	2.58
Grindelia squarrosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	7.0	0.0	0.75	2.09
Hypericum perforatum	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.53	1.59
Kuhnia eupatorides	0.0	17.5	0.0	0.0	0.0	5.7	0.0	4.6	10.4	0.0	3.82	5.68
Lactuca serriola	0.9	3.5	0.9	1.1	0.0	1.8	0.0	0.3	6.8	6.7	2.2	2.47
Psoralea tenuiflora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.72	2.16
Ratibida columnaris	0.0	0.0	12.8	0.0	0.0	0.0	0.0	5.1	0.0	7.1	2.5	4.22
Sphaelera coccinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.74	2.22
Tragopogon dubius	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.91	2.73
Subtotal, Forbs	2.2	34.7	20.2	11.8	17.6	13.8	42.5	19.3	78.0	34.4	27.45	20.41
TOTAL SPECIES	27	27	27	27	27	27	27	27	27	27	27	0
TOTAL WEIGHT	20.7	36.7	28.2	37.5	57.0	31.7	58.3	37.5	128.4	89.6	52.56	31.5
GRAMS/SQUARE METER	82.8	146.8	112.8	150.0	228.0	126.8	233.2	150.0	513.6	358.4	210.24	126.02
KILOGRAMS/HECTARE	828.0	1468.0	1128.0	1500.0	2280.0	1268.0	2332.0	1500.0	5136.0	3584.0	2102.4	1260.16
POUNDS/ACRE	738.7	1309.7	1006.4	1338.3	2034.2	1131.3	2080.6	1338.3	4582.3	3197.6	1875.76	1124.32

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Reference, 1991 (PRODGR91)

Study Site	MG01R	MG01R	MG01R	MG01R	MG01R	MG01R	MG01R	MG01R	MG01R	MG01R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	5.6	9.7	7.3	10.2	32.2	39.7	12.7	14.5	3.0	8.2	14.31	11.38
Aristida longiseta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.62	1.86
Bouteloua gracilis	14.0	7.3	4.3	12.7	0.0	0.0	18.4	6.1	3.3	14.6	8.07	6.15
Bromus japonicus	10.3	7.9	2.0	5.6	1.0	2.0	4.8	9.8	9.9	1.4	5.47	3.59
Bromus tectorum	0.9	0.8	0.8	1.2	0.2	0.0	0.6	0.4	1.0	0.3	0.62	0.37
Buchloe dactyloides	0.0	0.0	2.1	4.1	0.0	0.0	0.4	0.0	0.0	3.6	1.02	1.55
Subtotal, Graminoids	30.8	25.7	16.5	33.8	33.4	41.7	36.9	30.8	17.2	34.3	30.11	7.71
FORBS												
Agoseris sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.05	0.15
Ambrosia psilostachya	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.01	0.03
Aster ericoides	0.0	2.4	0.1	T	0.0	0.0	0.0	0.0	T	0.0	0.25	0.72
Astragalus sp.	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Carduus nutans	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.27	0.81
Chenopodium leptophyllum	0.0	1.9	0.0	0.0	0.0	0.0	T	0.0	0.0	0.4	0.23	0.57
Grindelia squarrosa	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.36
Helianthus annuus	0.0	0.0	0.0	0.0	0.0	5.5	2.4	0.8	0.4	0.0	0.91	1.69
Hypericum perforatum	6.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.93
Lactuca serriola	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.24	0.57
Miscellaneous small forbs	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Podospermum lancinatum	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.21
Potentilla gracilis	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.75
Psoralea tenuiflora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.36	1.08
Ratibida columnaris	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.18	0.54
Sphaeralcea coccinea	0.0	0.3	0.0	0.2	0.6	0.0	0.0	0.5	0.0	0.0	0.16	0.22
Tradescantia occidentalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.0	1.0	0.43	0.74
Unidentified crucifer	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.03	0.06
Vicia americana	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Subtotal, Forbs	11.6	5.7	1.8	3.4	0.6	5.7	2.4	3.6	7.4	1.8	4.4	3.13
TOTAL SPECIES	25	25	25	25	25	25	25	25	25	25	25	0
TOTAL WEIGHT	42.4	31.4	18.3	37.2	34.0	47.4	39.3	34.4	24.6	36.1	34.51	7.95
GRAMS/SQUARE METER	169.6	125.6	73.2	148.8	136.0	189.6	157.2	137.6	98.4	144.4	138.04	31.8
KILOGRAMS/HECTARE	1696.0	1256.0	732.0	1488.0	1360.0	1896.0	1572.0	1376.0	984.0	1444.0	1380.4	318
POUNDS/ACRE	1513.2	1120.6	653.1	1327.6	1213.4	1691.6	1402.5	1227.7	877.9	1288.3	1231.6	283.72
OTHER SPECIES PRESENT												
Echinocereus viridiflorus	0.0	0.0	4	0.0	0.0	0.0	0.0	0.0	1	0.0	0.5	1.2

T = trace amount

PRODGR91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Reference, 1991 (PRODGR91)

Study Site	MG02R	MG02R	MG02R	MG02R	MG02R	MG02R	MG02R	MG02R	MG02R	MG02R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	30-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	8.2	30.9	22.7	15.8	31.7	23.1	21.9	0.0	5.5	0.0	15.98	11.32
Andropogon gerardi	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.5	1.3	15.1	2.14	4.45
Aristida longiseta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.43	1.29
Bouteloua gracilis	1.2	0.0	6.5	0.3	0.0	3.7	4.0	0.0	1.4	0.6	1.77	2.11
Bromus japonicus	1.6	2.2	0.6	1.9	1.5	4.2	1.7	T	4.0	3.2	2.09	1.29
Bromus tectorum	0.8	0.7	1.3	2.2	0.0	0.7	0.0	T	0.3	0.0	0.6	0.68
Buchloe dactyloides	0.0	2.7	0.0	0.0	3.0	2.1	0.0	0.0	0.0	3.2	1.1	1.37
Carex stenophylla	0.0	0.0	0.0	0.0	0.0	0.0	10.7	18.1	13.3	0.0	4.21	6.65
Poa compressa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.4	1.2
Stipa comata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	3.6	8.7	1.83	3.02
Subtotal, Graminoids	11.8	36.5	31.1	20.2	36.2	33.8	39.8	31.9	33.4	30.8	30.55	7.95
FORBS												
Alyssum minus	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Ambrosia psilostachya	0.0	4.5	0.0	0.0	2.9	7.5	1.8	0.0	0.4	15.7	3.28	4.77
Artemesia frigida	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Artemesia ludoviciana	0.0	0.0	0.0	0.0	0.0	5.3	0.0	2.7	0.0	0.0	0.8	1.7
Aster falcatus	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.2	0.6
Chenopodium leptophyllum	0.0	0.0	0.1	0.6	0.4	0.2	0.4	0.0	0.0	0.0	0.17	0.21
Cirsium undulatum	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.35	1.05
Erigeron divergens	5.6	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.92	1.89
Heterotheca villosa	0.0	0.0	0.0	0.0	0.0	0.0	0.6	8.1	0.0	0.0	0.87	2.42
Hypericum perforatum	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Lactuca serriola	6.0	0.4	0.3	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.85	1.76
Miscellaneous small forbs	T	0.0	0.0	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.09	0.21
Psoralea tenuiflora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.17	0.51
Sphaeralcea coccinea	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.05	0.15
Unidentified borage	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.23	0.69
Unidentified crucifer	0.2	0.1	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.1	0.14
Subtotal, Forbs	12.0	5.0	8.1	4.6	4.6	15.3	3.5	10.8	2.1	15.7	8.17	4.73
TOTAL SPECIES	26	26	26	26	26	26	26	26	26	26	26	0
TOTAL WEIGHT	23.8	41.5	39.2	24.8	40.8	49.1	43.3	42.7	35.5	46.5	38.72	8.03
GRAMS/SQUARE METER	95.2	166.0	156.8	99.2	163.2	196.4	173.2	170.8	142.0	186.0	154.88	32.1
KILOGRAMS/HECTARE	952.0	1660.0	1568.0	992.0	1632.0	1964.0	1732.0	1708.0	1420.0	1860.0	1548.8	321.03
POUNDS/ACRE	849.4	1481.1	1399.0	885.1	1456.1	1752.3	1545.3	1523.9	1266.9	1659.5	1381.8	286.42
OTHER SPECIES PRESENT												
Opuntia fragilis	0.0	0.0	0.0	0.0	1	0.0	0.0	0.0	0.0	0.0	0.1	0.3

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Mesic Grassland, Reference, 1991 (PRODGR91)

Study Site	MG03R	MG03R	MG03R	MG03R	MG03R	MG03R	MG03R	MG03R	MG03R	MG03R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	10-Oct	mean	stdev
GRAMINOIDS												
Agropyron smithii	27.7	25.5	21.6	11.5	6.1	15.7	10.8	1.0	0.3	3.5	12.37	9.49
Andropogon gerardi	17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.72	5.16
Bouteloua curtipendula	3.8	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.89	1.8
Bouteloua gracilis	1.3	6.0	14.1	8.5	1.4	0.0	0.0	0.0	0.0	0.0	3.13	4.61
Bromus japonicus	0.0	0.0	T	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.03	0.09
Buchloe dactyloides	0.0	5.9	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.83	1.84
Carex filifolia	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Carex stenophylla	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9
Festuca pratensis	0.0	0.0	0.0	8.8	29.5	18.9	7.9	110.7	32.5	38.4	24.67	31.73
Juncus balticus	0.0	0.0	0.0	0.0	0.0	6.8	3.1	0.0	0.0	0.8	1.07	2.12
Poa compressa	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.4	14.2	4.2	2.04	4.24
Poa pratensis	1.4	0.4	0.0	0.3	0.0	23.5	8.9	1.4	0.0	8.4	4.43	7.14
Stipa comata	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.21	0.63
Subtotal, Graminoids	53.5	37.8	40.8	32.1	38.2	64.9	33.4	114.5	47.0	55.3	51.75	23.17
FORBS												
Achillea millefolium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.05	0.15
Agoseris sp.	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Alyssum minus	1.5	1.1	1.0	2.1	0.1	0.0	0.3	0.0	0.0	0.0	0.61	0.72
Ambrosia psilostachya	0.0	0.0	0.0	0.0	0.7	0.0	0.9	0.0	0.0	0.0	0.16	0.32
Artemesia ludoviciana	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.62	1.86
Cirsium undulatum	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Psoralea tenuiflora	0.0	1.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.51	1.23
Tragopogon dubius	1.4	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.46	1
Unidentified crucifer	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Subtotal, Forbs	2.9	2.1	8.7	2.3	7.0	0.0	1.2	0.0	0.0	0.5	2.47	2.89
TOTAL SPECIES	22	22	22	22	22	22	22	22	22	22	22	0
TOTAL WEIGHT	56.4	39.9	49.5	34.4	45.2	64.9	34.6	114.5	47.0	55.8	54.22	22.12
GRAMS/SQUARE METER	225.6	159.6	198.0	137.6	180.8	259.6	138.4	458.0	188.0	223.2	216.88	88.49
KILOGRAMS/HECTARE	2256.0	1596.0	1980.0	1376.0	1808.0	2596.0	1384.0	4580.0	1880.0	2232.0	2168.8	884.86
POUNDS/ACRE	2012.8	1424.0	1766.6	1227.7	1613.1	2316.2	1234.8	4086.3	1677.3	1991.4	1935	789.47
OTHER SPECIES PRESENT												
Opuntia polyacantha	0.0	1	1	0.0	0.0	0.0	1	0.0	0.0	0.0	0.3	0.46
Rosa arkansana	0.0	0.0	0.0	0.0	0.0	0.0	5	0.0	0.0	0.0	0.5	1.5

T = trace amount

PRODGR91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Xeric Grassland, Study, 1991 (PRODXA91)

Study Site	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	mean	stdev
GRAMINOIDS												
Agropyron cristatum	0.0	0.0	0.0	0.0	0.0	0.0	15.2	12.1	0.0	0.5	2.78	5.48
Aristida p. robusta	0.0	0.7	0.0	0.0	0.0	0.0	2.2	0.2	0.0	0.8	0.39	0.67
Bromus inermis	25.5	30.2	22.7	17.3	23.5	18.6	12.3	35.8	20.6	30.9	23.74	6.72
Buchloe dactyloides	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.22	0.66
Subtotal, Graminoids	25.5	30.9	22.7	17.3	23.5	20.8	29.7	48.1	20.6	32.2	27.13	8.37
FORBS												
Grindelia squarrosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.4	0.0	3.54	10.62
Melilotus officinalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.35	1.05
Subtotal, Forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.4	3.5	3.89	10.56
TOTAL SPECIES	6	6	6	6	6	6	6	6	6	6	6	0
TOTAL WEIGHT	25.5	30.9	22.7	17.3	23.5	20.8	29.7	48.1	56.0	35.7	31.02	11.78
GRAMS/SQUARE METER	102.0	123.6	90.8	69.2	94.0	83.2	118.8	192.4	224.0	142.8	124.08	47.13
KILOGRAMS/HECTARE	1020.0	1236.0	908.0	692.0	940.0	832.0	1188.0	1924.0	2240.0	1428.0	1240.8	471.31
POUNDS/ACRE	910.0	1102.8	810.1	617.4	838.7	742.3	1059.9	1716.6	1998.5	1274.1	1107.04	420.5

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Xeric Grassland, Study ,1991 (PRODXA91)

Study Site	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A		
Plot	11	12	13	14	15	16	17	18	19	20		
Date	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	mean	stdev
GRAMINOIDS												
Agropyron cristatum	0.0	0.0	0.0	9.7	0.0	0.0	0.0	19.5	25.5	0.0	5.47	9.09
Agropyron smithii	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Aristida p.robusta	0.7	0.0	12.4	0.0	5.9	6.2	6.9	0.0	0.1	3.0	3.52	4
Bouteloua gracilis	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.04	0.08
Bromus inermis	10.9	0.0	1.2	1.4	11.4	7.0	1.6	0.0	0.0	10.8	4.43	4.73
Bromus tectorum	8.9	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	1.01	2.65
Subtotal, Graminoids	20.5	0.0	13.8	11.1	18.5	13.2	8.7	19.5	25.6	14.0	14.49	6.77
FORBS												
Alyssum minus	1.9	1.1	1.2	0.0	0.5	0.0	1.2	0.4	0.0	0.0	0.63	0.64
Ambrosia psilostachya	0.2	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.36
Chrysopsis villosa	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.42
Convolvulus arvensis	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	6
Dyssodia papposa	0.3	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.25	0.66
Grindelia squarrosa	0.2	40.5	22.4	18.4	0.7	37.7	0.0	0.0	0.0	52.0	17.19	19.11
Melilotus officinalis	0.9	0.1	17.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.91	5.05
Verbascum thapsus	0.0	1.6	46.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.83	13.96
Subtotal, Forbs	3.5	43.3	108.7	20.7	3.4	37.7	1.2	0.4	0.0	52.0	27.09	33.06
TOTAL SPECIES	14	14	14	14	14	14	14	14	14	14	14	0
TOTAL WEIGHT	24.0	43.3	122.5	31.8	21.9	50.9	9.9	19.9	25.6	66.0	41.58	31.23
GRAMS/SQUARE METER	96.0	173.2	490.0	127.2	87.6	203.6	39.6	79.6	102.4	264.0	166.32	124.93
KILOGRAMS/HECTARE	960.0	1732.0	4900.0	1272.0	876.0	2036.0	396.0	796.0	1024.0	2640.0	1663.2	1249.33
POUNDS/ACRE	856.5	1545.3	4371.8	1134.9	781.6	1816.5	353.3	710.2	913.6	2355.4	1483.91	1114.66

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Xeric Grassland, Study, 1991 (PRODXA91)

Study Site	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A	MX01A		
Plot	21	22	23	24	25	26	27	28	29	30		
Date	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	mean	stdev
GRAMINOIDS												
Agropyron cristatum	0.0	0.0	0.0	2.8	0.0	9.9	0.0	0.0	0.0	0.0	1.27	3
Aristida p. robusta	18.4	29.5	6.9	2.9	8.5	7.3	5.8	17.6	1.1	22.7	12.07	8.91
Bromus inermis	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.7	56.3	0.0	5.71	16.86
Bromus tectorum	1.5	0.5	0.0	0.0	1.7	0.0	0.3	0.9	0.7	3.8	0.94	1.11
Hordeum jubatum	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15	0.45
Sporobolus cryptandrus	2.8	0.0	0.0	0.3	0.0	0.0	9.9	2.6	9.1	0.0	2.47	3.67
Subtotal, Graminoids	22.7	31.5	6.9	6.0	10.3	17.2	16.0	21.8	67.2	26.5	22.61	16.82
FORBS												
Agoseris glauca	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.01	0.03
Alyssum minus	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.03	0.09
Ambrosia psilostachya	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.22	0.45
Conyza canadensis	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Dyssodia papposa	0.0	0.0	0.0	0.0	0.1	0.5	0.2	0.0	0.0	0.0	0.08	0.16
Erodium cicutarium	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.15	0.45
Grindelia squarrosa	0.0	0.0	0.7	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.27	0.61
Melilotus officinalis	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Salsola iberica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.03	0.09
Verbascum thapsus	0.0	0.0	0.0	0.0	0.0	6.9	4.2	0.0	0.0	0.0	1.11	2.3
Subtotal, Forbs	0.0	0.0	1.6	0.0	0.9	11.0	4.7	0.0	1.3	0.3	1.98	3.3
TOTAL SPECIES	16	16	16	16	16	16	16	16	16	16	16	0
TOTAL WEIGHT	22.7	31.5	8.5	6.0	11.2	28.2	20.7	21.8	68.5	26.8	24.59	16.75
GRAMS/SQUARE METER	90.8	126.0	34.0	24.0	44.8	112.8	82.8	87.2	274.0	107.2	98.36	66.98
KILOGRAMS/HECTARE	908.0	1260.0	340.0	240.0	448.0	1128.0	828.0	872.0	2740.0	1072.0	983.6	669.81
POUNDS/ACRE	810.1	1124.2	303.3	214.1	399.7	1006.4	738.7	778.0	2444.6	956.4	877.57	597.6

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Xeric Grassland, Reference (PRODXR91)

Study Site	MX01R	MX01R	MX01R	MX01R	MX01R	MX01R	MX01R	MX01R	MX01R	MX01R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	mean	stdev
GRAMINOIDS												
Andropogon gerardii	11.9	9.6	7.3	7.8	1.4	1.0	3.6	3.3	5.2	2.4	5.35	3.48
Andropogon scoparius	1.6	2.9	0.0	7.6	6.9	5.7	6.8	9.4	4.8	0.6	4.63	3.04
Bouteloua hirsuta	0.0	0.0	0.0	0.0	0.9	0.3	0.4	1.5	0.6	0.0	0.37	0.48
Carex filifolia	0.0	0.7	0.0	1.1	0.0	1.0	1.1	0.8	0.0	0.0	0.47	0.48
Carex stenophylla	0.0	1.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.21	0.43
Koeleria pyramidata	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.6	1.8	0.5	0.53	0.72
Muhlenbergia montana	10.6	6.4	0.4	15.4	2.3	0.1	1.7	0.0	2.2	3.5	4.26	4.84
Poa compressa	3.8	0.6	0.0	0.0	1.1	0.0	0.0	0.0	5.0	0.0	1.05	1.73
Stipa, sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6	1.16	3.48
Subtotal, Graminoids	27.9	21.4	8.6	31.9	12.6	8.1	15.0	16.6	19.6	18.6	18.03	7.3
FORBS												
Arenaria fendleri	0.0	0.0	0.0	0.0	0.0	1.0	0.8	1.7	2.3	0.0	0.58	0.8
Arnica fulgens	0.0	0.0	0.0	0.0	0.0	2.6	0.0	3.1	0.0	0.0	0.57	1.15
Artemisia ludoviciana	0.0	0.0	0.0	0.5	0.0	0.0	1.5	T	0.0	0.0	0.2	0.46
Aster porteri	5.1	10.9	21.7	1.4	1.5	6.4	0.8	3.0	3.7	5.8	6.03	5.95
Eriogonum alatum	0.0	0.4	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.13	0.28
Hypericum perforatum	0.0	0.2	0.2	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.07	0.08
Liatris punctata	0.0	0.0	0.0	1.0	8.0	2.3	3.7	2.8	1.3	1.5	2.06	2.31
Linaria dalmatica	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.1	0.8	0.25	0.4
Petalostemon purpureum	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.09	0.21
Sedum lanceolatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.01	0.03
Solidago missouriensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.4	0.17	0.42
Talinum parviflorum	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.06	0.1
Unid. Composite (YYG)	0.1	0.0	0.1	0.0	3.4	0.0	4.0	0.0	0.4	0.8	0.88	1.44
Subtotal, Forbs	5.2	11.5	22.9	3.2	13.9	13.0	10.9	10.9	9.2	10.3	11.1	5.02
TOTAL SPECIES	22	22	22	22	22	22	22	22	22	22	22	0
TOTAL WEIGHT	33.1	32.9	31.5	35.1	26.5	21.1	25.9	27.5	28.8	28.9	29.13	3.95
GRAMS/SQUARE METER	132.4	131.6	126.0	140.4	106.0	84.4	103.6	110.0	115.2	115.6	116.52	15.79
KILOGRAMS/HECTARE	1324.0	1316.0	1260.0	1404.0	1060.0	844.0	1036.0	1100.0	1152.0	1156.0	1165.2	157.93
POUNDS/ACRE	1181.3	1174.1	1124.2	1252.6	945.7	753.0	924.3	981.4	1027.8	1031.4	1039.59	140.9
OTHER SPECIES PRESENT												
Echinocereus viridiflorus	0	0	0	0	0	1	3	4	0	1	0	0

T = trace amount

PRODXR91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Xeric Grassland, Reference (PRODXR91)

Study Site	MX03R	MX03R	MX03R	MX03R	MX03R	MX03R	MX03R	MX03R	MX03R	MX03R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	13-Sep	mean	stdev
GRAMINOIDS												
Andropogon gerardii	6.6	0.4	10.6	20.6	1.2	8.8	13.8	8.1	14.8	0.0	8.49	6.43
Andropogon scoparius	4.4	0.5	0.0	0.0	0.0	1.8	1.1	0.0	0.0	0.0	0.78	1.34
Aristida longiseta	0.4	0.0	0.0	0.0	0.0	0.2	0.0	1.6	4.1	0.0	0.63	1.25
Bouteloua gracilis	0.0	0.0	0.0	3.2	2.0	0.4	0.7	0.9	0.0	0.0	0.72	1.03
Buchloe dactyloides	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7	0.9	0.0	0.2	0.33
Carex stenophylla	4.9	0.0	0.0	0.0	0.0	7.5	2.0	0.0	0.0	0.0	1.44	2.52
Koeleria pyramidata	0.0	0.9	0.0	2.5	0.0	0.0	1.3	2.5	0.0	0.0	0.72	0.99
Muhlenbergia montana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.03	0.09
Poa compressa	0.0	0.5	16.2	0.0	0.5	0.0	0.4	0.0	0.0	25.9	4.35	8.63
Subtotal, Graminoids	16.3	2.3	26.8	26.3	4.1	18.7	19.3	14.1	19.8	25.9	17.36	8.17
FORBS												
Ambrosia psilostachya	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Arenaria fendleri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.17	0.51
Artemisia frigida	0.0	0.0	1.4	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.17	0.41
Aster porteri	2.3	7.1	0.0	0.0	3.2	0.0	0.0	4.2	4.3	0.6	2.17	2.35
Erigeron flagellaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.07	0.21
Eriogonum alatum	0.0	0.0	0.0	0.0	0.3	0.5	1.4	0.0	0.0	0.0	0.22	0.43
Heterotheca villosa	0.0	13.6	14.4	2.0	9.3	3.0	0.0	0.0	2.8	2.1	4.72	5.3
Hymenopappus filifolius	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.26	0.78
Hypericum perforatum	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Liatris punctata	4.6	24.5	0.0	0.0	1.5	1.3	5.3	1.4	10.4	14.7	6.37	7.58
Linaria dalmatica	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.4	0.0	0.19	0.32
Melandrium sp.	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Paronychia jamesii	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.24	0.72
Phacelia heterophylla	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.11	0.33
Podospermum lanciniatum	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Tragopogon dubius	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11	0.33
Unid. Forb 1	0.0	0.0	0.0	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.11	0.23
Subtotal, Forbs	6.9	46.3	16.9	2.4	19.1	4.9	7.7	6.3	19.6	21.1	15.12	12.3
TOTAL SPECIES	26	26	26	26	26	26	26	26	26	26	26	0
TOTAL WEIGHT	23.2	48.6	43.7	28.7	23.2	23.6	27.0	20.4	39.4	47.0	32.48	10.42
GRAMS/SQUARE METER	92.9	194.4	174.8	114.8	92.8	94.4	108.0	81.6	157.6	188.0	129.93	41.67
KILOGRAMS/HECTARE	928.8	1944.0	1748.0	1148.0	928.0	944.0	1080.0	816.0	1576.0	1880.0	1299.28	416.73
POUNDS/ACRE	828.7	1734.4	1559.6	1024.2	828.0	842.2	963.6	728.0	1406.1	1677.3	1159.22	371.81
OTHER SPECIES PRESENT												
Echinocereus viridiflorus	3	1	0	0	7	2	4	3	2	5	0	0

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Study, 1991 (PRODAA91)

Study Site	MA01A	MA01A	MA01A	MA01A	MA01A	MA01A	MA01A	MA01A	MA01A	MA01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	24.6	30.2	26.3	15.3	3.4	2.1	6.5	6.0	6.0	9.1	12.95	9.89
Carex stenophylla	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Eleocharis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.12	0.36
Poa compressa	6.5	6.4	9.8	20.2	32.0	101.9	53.1	0.0	8.2	0.0	23.81	30.35
Poa pratensis	0.0	3.6	7.9	1.6	9.0	0.0	0.0	7.5	2.4	0.0	3.2	3.44
Sporobolus heterolepus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	20.2	23.6	6.57	10.06
Subtotal, Graminoids	31.5	40.2	44.0	37.1	44.4	104.0	59.6	35.4	36.8	33.9	46.69	20.54
FORBS												
Ambrosia psilostachya	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.68	2.04
Aster falcatus	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15	0.45
Cirsium arvense	1.0	7.3	2.6	10.0	2.1	41.2	19.0	13.0	28.2	80.5	20.49	23.39
Convolvulus arvensis	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Melilotus officinalis	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.36
Miscellaneous small forbs	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Verbascum thapsus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.01	0.03
Subtotal, Forbs	10.9	7.3	2.9	10.0	2.1	41.2	19.0	13.0	28.3	80.5	21.52	22.72
TOTAL SPECIES	13	13	13	13	13	13	13	13	13	13	13	0
TOTAL WEIGHT	42.4	47.5	46.9	47.1	46.5	145.2	78.6	48.4	65.1	114.4	68.21	33.22
GRAMS/SQUARE METER	169.6	190.0	187.6	188.4	186.0	580.8	314.4	193.6	260.4	457.6	272.84	132.89
KILOGRAMS/HECTARE	1696.0	1900.0	1876.0	1884.0	1860.0	5808.0	3144.0	1936.0	2604.0	4576.0	2728.4	1328.89
POUNDS/ACRE	1513.2	1695.2	1673.8	1680.9	1659.5	5181.9	2805.1	1727.3	2323.3	4082.7	2434.28	1185.64

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Study, 1991 (PRODAA91)

Study Site	MA03A	MA03A	MA03A	MA03A	MA03A	MA03A	MA03A	MA03A	MA03A	MA03A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	20-Sep	mean	stdev
GRAMINOIDS												
Agropyron smithii	1.1	0.0	0.0	0.0	0.6	0.0	0.9	0.9	0.0	0.0	0.35	0.44
Dactylis glomerata	28.0	9.8	0.6	1.8	0.0	0.0	13.2	0.0	0.0	0.0	5.34	8.79
Juncus dudleyi	10.3	3.6	1.5	1.3	13.1	5.4	1.7	7.6	0.0	7.0	5.15	4.1
Poa compressa	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Poa pratensis	0.0	1.0	0.3	1.8	1.8	6.2	1.8	0.7	0.0	0.0	1.36	1.77
Typha angustifolia	0.0	111.8	180.5	74.9	31.9	39.8	0.0	0.0	40.0	56.8	53.57	54.24
Typha latifolia	48.4	0.0	0.0	0.0	0.0	88.9	374.3	116.9	0.0	0.0	62.85	111.58
Unidentified grass seedl.	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.05	0.15
Subtotal, Graminoids	88.4	126.2	182.9	79.8	47.4	140.8	391.9	126.1	40.0	63.8	128.73	97.51
FORBS												
Asclepias speciosa	0.0	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.0	0.0	0.98	2.94
Carduus nutans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	0.0	0.0	3.15	9.45
Cirsium arvense	12.7	1.9	0.4	7.7	28.1	6.1	9.7	14.8	20.0	6.9	10.83	7.99
Croton texensis	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Epilobium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.3
Melilotus officinalis	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.06	0.18
Mentha arvensis	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Oenothera strigosa	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.03	0.09
Rumex crispus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.08	0.24
Sonchus uglinosus	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.39	1.17
Subtotal, Forbs	12.8	1.9	0.6	11.6	28.1	6.4	20.1	46.3	20.0	8.7	15.65	13.07
TOTAL SPECIES	18	18	18	18	18	18	18	18	18	18	18	0
TOTAL WEIGHT	101.2	128.1	183.5	91.4	75.5	147.2	412.0	172.4	60.0	72.5	144.38	97.93
GRAMS/SQUARE METER	404.8	512.4	734.0	365.6	302.0	588.8	1648.0	689.6	240.0	290.0	577.52	391.74
KILOGRAMS/HECTARE	4048.0	5124.0	7340.0	3656.0	3020.0	5888.0	16480.0	6896.0	2400.0	2900.0	5775.2	3917.38
POUNDS/ACRE	3611.6	4571.6	6548.7	3261.9	2694.4	5253.3	14703.5	6152.6	2141.3	2587.4	5152.63	3495.08

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Study ,1991 (PRODAA91)

Study Site	MA04A	MA04A	MA04A	MA04A	MA04A	MA04A	MA04A	MA04A	MA04A	MA04A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	mean	stdev
GRAMINOIDS												
Buchloe dactyloides	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Echinochloa crusgallii	39.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.97	11.91
Hordeum jubatum	0.0	47.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.74	14.22
Panicum capillare	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Typha angustifolia	0.0	0.0	53.6	64.9	62.0	12.2	0.0	66.5	0.0	160.8	42	48.7
Typha latifolia	0.0	0.0	92.8	0.0	17.5	31.5	56.2	0.0	17.1	25.3	24.04	28.67
Subtotal, Graminoids	40.3	47.4	146.7	64.9	79.5	43.7	56.2	66.5	17.1	186.1	74.84	49.33
FORBS												
Ambrosia psilostachya	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.22	3.66
Cirsium arvense	7.7	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.91	2.3
Epilobium sp.	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Helianthus annuus	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.73	2.19
Miscellaneous small forbs	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09	0.27
Subtotal, Forbs	27.2	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.98	8.11
TOTAL SPECIES	11	11	11	11	11	11	11	11	11	11	11	0
TOTAL WEIGHT	67.5	47.4	149.3	64.9	79.5	43.7	56.2	66.5	17.1	186.1	77.82	48.46
GRAMS/SQUARE METER	270.0	189.6	597.2	259.6	318.0	174.8	224.8	266.0	68.4	744.4	311.28	193.83
KILOGRAMS/HECTARE	2700.0	1896.0	5972.0	2596.0	3180.0	1748.0	2248.0	2660.0	684.0	7444.0	3112.8	1938.34
POUNDS/ACRE	2408.9	1691.6	5328.2	2316.2	2837.2	1559.6	2005.7	2373.3	610.3	6641.5	2777.24	1729.39

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Reference, 1991 (PRODAR91)

Study Site	MA01R	MA01R	MA01R	MA01R	MA01R	MA01R	MA01R	MA01R	MA01R	MA01R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	mean	stdev
GRAMINOIDS												
Carex lanuginosa	0.0	0.0	0.0	0.0	10.8	0.0	0.0	0.0	0.0	0.0	1.08	3.24
Juncus balticus	31.3	30.1	45.8	24.8	22.4	43.2	24.7	32.0	8.0	6.2	26.85	12.22
Miscellaneous grasses	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Poa pratensis	0.1	0.2	T	T	0.0	0.0	0.0	16.4	0.9	0.0	1.76	4.89
Unidentified grass seedl.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	3.2	0.6	1.2
Subtotal, Graminoids	31.4	30.3	45.8	24.8	33.4	43.2	24.7	48.4	11.7	9.4	30.31	12.61
FORBS												
Barbarea orthoceras	4.3	0.2	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.27
Cirsium arvense	86.1	29.6	43.4	31.9	22.7	47.6	28.3	T	29.6	27.0	34.62	20.96
Miscellaneous small forbs	0.0	0.2	0.0	T	0.0	0.0	0.0	0.0	0.0	T	0.02	0.06
Ranunculus macounii	0.0	6.4	0.0	0.5	0.0	0.0	0.0	0.3	0.0	0.0	0.72	1.9
Unidentified crucifer	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.29	0.87
Verbascum thapsus	0.0	0.0	0.0	T	13.9	0.0	0.0	0.0	0.0	0.0	1.39	4.17
Subtotal, Forbs	90.4	36.4	47.3	32.9	36.6	47.6	28.3	0.3	29.6	27.0	37.64	21.59
TOTAL SPECIES	11	11	11	11	11	11	11	11	11	11	11	0
TOTAL WEIGHT	121.8	66.7	93.1	57.7	70.0	90.8	53.0	48.7	41.3	36.4	67.95	25.43
GRAMS/SQUARE METER	487.2	266.8	372.4	230.8	280.0	363.2	212.0	194.8	165.2	145.6	271.8	101.71
KILOGRAMS/HECTARE	4872.0	2668.0	3724.0	2308.0	2800.0	3632.0	2120.0	1948.0	1652.0	1456.0	2718	1017.05
POUNDS/ACRE	4346.8	2380.4	3322.6	2059.2	2498.2	3240.5	1891.5	1738.0	1473.9	1299.0	2425	907.42

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Reference, 1991 (PRODAR91)

Study Site	MA02R	MA02R	MA02R	MA02R	MA02R	MA02R	MA02R	MA02R	MA02R	MA02R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	mean	stdev
GRAMINOIDS												
Carex nebraskensis	8.7	T	0.0	0.0	0.0	0.0	0.0	0.0	4.5	114.6	12.78	34.05
Juncus balticus	26.3	1.5	0.0	0.0	21.6	39.9	48.0	29.6	0.0	0.0	16.69	17.74
Juncus dudleyi	0.6	0.7	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.18	0.28
Poa pratensis	1.0	0.0	0.0	0.0	0.0	0.2	0.2	1.7	2.4	0.0	0.55	0.82
Typha angustifolia	0.0	61.0	27.2	36.0	0.0	0.0	0.0	0.0	0.0	0.0	12.42	20.53
Typha latifolia	0.0	38.4	22.6	64.5	0.3	0.0	0.0	0.0	0.0	0.0	12.58	21.36
Unidentified grass seedl.	T	0.0	0.0	0.0	T	0.6	0.0	0.0	0.0	0.0	0.06	0.18
Subtotal, Graminoids	36.6	101.6	49.8	100.5	22.4	40.7	48.2	31.3	6.9	114.6	55.26	35.14
FORBS												
Barbarea orthoceras	0.4	0.2	5.2	0.4	1.4	2.3	0.1	0.0	0.0	0.4	1.04	1.55
Cirsium arvense	0.0	0.0	0.1	0.0	0.4	1.9	13.5	12.7	1.5	6.1	3.62	5.06
Epilobium sp.	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	6.9	0.8	2.05
Hypericum perforatum	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.04	0.08
Mentha arvensis	0.1	0.0	0.0	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.16	0.32
Miscellaneous small forbs	0.1	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.08	0.1
Potentilla hippiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.32	0.96
Ranunculus macounii	0.0	0.0	0.0	0.0	4.8	9.7	0.3	T	3.1	10.8	2.87	4.01
Rumex obtusifolia	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Scrophularia lanceolata	0	0	0	0	0	0	0	0	0	3.5	0.35	1.05
Viola nephrophylla	3.8	0.0	0.0	0.2	0.4	0.2	0.2	0.0	0.0	0.0	0.48	1.11
Subtotal, Forbs	4.4	1.7	5.3	0.9	7.7	14.1	14.4	16.1	5.9	27.7	9.82	7.83
TOTAL SPECIES	18	18	18	18	18	18	18	18	18	18	18	0
TOTAL WEIGHT	41.0	103.3	55.1	101.4	30.1	54.8	62.6	47.4	12.8	142.3	65.08	37.15
GRAMS/SQUARE METER	164.0	413.2	220.4	405.6	120.4	219.2	250.4	189.6	51.2	569.2	260.32	148.61
KILOGRAMS/HECTARE	1640.0	4132.0	2204.0	4056.0	1204.0	2192.0	2504.0	1896.0	512.0	5692.0	2603.2	1486.12
POUNDS/ACRE	1463.2	3686.6	1966.4	3618.8	1074.2	1955.7	2234.1	1691.6	456.8	5078.4	2322.58	1325.92

T = trace amount

PRODAR91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Marshland, Reference, 1991 (PRODAR91)

Study Site	MA03R	MA03R	MA03R	MA03R	MA03R	MA03R	MA03R	MA03R	MA03R	MA03R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	03-Oct	mean	stdev
GRAMINOIDS												
Agropyron smithii	6.3	8.0	4.7	3.9	10.7	5.1	0.0	0.0	0.0	0.0	3.87	3.63
Andropogon gerardi	8.0	10.1	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	1.96	3.6
Bouteloua gracilis	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.13	0.39
Bromus japonicus	0.0	0.6	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.15	0.26
Carex stenophylla	0.0	2.5	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.46	3.62
Juncus balticus	0.0	3.9	5.3	0.0	5.2	0.0	42.6	54.4	23.5	53.8	18.87	21.75
Juncus dudleyi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.04	0.12
Miscellaneous grasses	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.0	0.0	0.09	0.18
Poa pratensis	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	3.5	7.5	1.27	2.35
Scirpus americanus	0.0	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.27	3.81
Unidentified grass seedl.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.11	0.33
Subtotal, Graminoids	14.3	26.8	35.0	4.6	15.9	7.9	43.1	55.2	28.1	61.3	29.22	18.43
FORBS												
Alyssum minus	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Artemesia ludoviciana	0.0	0.0	0.0	33.7	0.0	0.0	0.0	0.0	0.0	0.0	3.37	10.11
Centaurea diffusa	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.63	1.89
Centaurea repens	0.0	0.0	0.0	0.0	0.0	9.6	0.0	0.0	0.0	0.0	0.96	2.88
Cirsium arvense	47.7	18.7	5.1	0.0	5.2	0.0	1.6	7.9	18.7	6.0	11.09	13.78
Epilobium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.06	0.18
Equisetum laevigatum	T	0.2	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.09	0.21
Hypericum perforatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.03	0.09
Miscellaneous small forbs	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Potentilla sp.	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Ratibida columnaris	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.5	1.5
Unidentified basal leaf	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.28	0.84
Verbascum thapsus	0.0	0.0	0.0	0.0	13.4	0.0	0.0	0.0	0.0	0.0	1.34	4.02
Subtotal, Forbs	47.7	18.9	6.1	33.7	28.7	14.6	1.6	7.9	18.7	6.9	18.48	13.75
TOTAL SPECIES	24	24	24	24	24	24	24	24	24	24	24	0
TOTAL WEIGHT	62.0	45.7	41.1	38.3	44.6	22.5	44.7	63.1	46.8	68.2	47.7	12.85
GRAMS/SQUARE METER	248.0	182.8	164.4	153.2	178.4	90.0	178.8	252.4	187.2	272.8	190.8	51.42
KILOGRAMS/HECTARE	2480.0	1828.0	1644.0	1532.0	1784.0	900.0	1788.0	2524.0	1872.0	2728.0	1908	514.16
POUNDS/ACRE	2212.7	1630.9	1466.8	1366.9	1591.7	803.0	1595.3	2251.9	1670.2	2433.9	1702.32	458.74

T = trace amount

PRODAR9 3/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Study, 1991 (PRODWA91)

Study Site	MW01A	MW01A	MW01A	MW01A	MW01A	MW01A	MW01A	MW01A	MW01A	MW01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	12-Sep	mean	stdev
GRAMINOIDS												
Bromus inermis	27.3	17.2	7.5	2.9	24.1	16.1	27.5	55.9	16.6	59.3	25.44	17.74
Panicum capillare	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.03	0.09
Poa compressa	0.0	0.0	0.7	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.45	1.14
Subtotal, Graminoids	27.3	17.2	8.2	6.7	24.1	16.1	27.5	55.9	16.6	59.6	25.92	17.27
FORBS												
Asclepias speciosa	0.0	0.0	0.0	10.8	0.0	0.0	0.0	0.0	0.0	0.0	1.08	3.24
Cirsium arvense	4.1	0.0	0.0	29.1	5.7	4.4	0.7	0.0	0.0	0.0	4.4	8.5
Subtotal, Forbs	4.1	0.0	0.0	39.9	5.7	4.4	0.7	0.0	0.0	0.0	5.48	11.67
TOTAL SPECIES	5	5	5	5	5	5	5	5	5	5	5	0
TOTAL WEIGHT	31.4	17.2	8.2	46.6	29.8	20.5	28.2	55.9	16.6	59.6	31.4	16.48
GRAMS/SQUARE METER	125.6	68.8	32.8	186.4	119.2	82.0	112.8	223.6	66.4	238.4	125.6	65.93
KILOGRAMS/HECTARE	1256.0	688.0	328.0	1864.0	1192.0	820.0	1128.0	2236.0	664.0	2384.0	1256	659.34
POUNDS/ACRE	1120.6	613.8	292.6	1663.1	1063.5	731.6	1006.4	1995.0	592.4	2127.0	1120.6	588.26

T = trace amount

PRRIP91A.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Study, 1991 (PRODWA91)

Study Site	MW02A	MW02A	MW02A	MW02A	MW02A	MW02A	MW02A	MW02A	MW02A	MW02A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	27-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.12	0.36
Carex nebraskensis	0.0	0.0	9.3	0.0	16.7	0.0	15.1	0.0	13.0	1.3	5.54	6.76
Carex sp.	0.0	0.0	0.0	0.0	0.0	0.0	16.7	12.0	2.4	3.1	3.42	5.67
Juncus balticus	0.0	0.0	0.8	5.5	1.4	0.0	2.9	20.3	5.9	7.0	4.38	5.88
Juncus dudleyi	0.0	0.0	0.0	5.1	0.3	0.0	0.0	0.0	0.0	0.0	0.54	1.52
Miscellaneous grasses	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.4	0.15	0.42
Poa pratensis	9.3	13.7	0.0	0.0	2.8	0.0	4.6	5.5	3.9	7.7	4.75	4.27
Typha latifolia	0.0	0.0	0.0	0.0	0.0	106.3	0.0	0.0	0.0	0.0	10.63	31.89
Subtotal, Graminoids	9.3	13.7	10.1	10.7	21.2	106.3	39.3	37.8	26.4	20.5	29.53	27.59
FORBS												
Cirsium arvense	0.0	0.0	4.8	1.0	0.0	0.0	0.0	4.0	0.0	0.0	0.98	1.74
Miscellaneous small forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.07	0.21
Oxalis dillenii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.05	0.15
Ranunculus macounii	0.0	0.0	0.0	10.6	17.0	0.0	0.0	0.0	6.7	0.8	3.51	5.69
Rumex sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.3
Stachys palustris	0.0	0.0	1.1	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.15	0.34
Solidago missouriensis	0.0	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.66	1.98
Taraxacum officinale	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Thermopsis divaricarpa	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05	0.15
Subtotal, Forbs	0.1	7.1	5.9	11.6	17.4	0.0	0.0	4.0	8.4	1.3	5.58	5.47
TOTAL SPECIES	17	17	17	17	17	17	17	17	17	17	17	0
TOTAL WEIGHT	9.4	20.8	16.0	22.3	38.6	106.3	39.3	41.8	34.8	21.8	35.11	25.91
GRAMS/SQUARE METER	37.6	83.2	64.0	89.2	154.4	425.2	157.2	167.2	139.2	87.2	140.44	103.65
KILOGRAMS/HECTARE	376.0	832.0	640.0	892.0	1544.0	4252.0	1572.0	1672.0	1392.0	872.0	1404.4	1036.52
POUNDS/ACRE	335.5	742.3	571.0	795.8	1377.6	3793.6	1402.5	1491.8	1241.9	778.0	1253.01	924.78
OTHER SPECIES PRESENT												
Amorpha fruticosa	2	0.0	3	7	6	0.0	0.0	0.0	2	0.0	2	2.49
Salix exigua	0.0	0.0	0.0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3

T = trace amount

PRRIP91A [illegible]/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Study, 1991 (PRODWA91)

Study Site	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	4.6	0.0	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.62	1.36
Bromus inermis	0.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.19	0.38
Carex nebraskensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.37	1.11
Elymus canadensis	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6
Poa pratensis	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.36	1.08
Typha latifolia	0.0	0.0	0.0	0.0	0.0	0.0	27.6	0.0	0.2	73.5	10.13	22.67
Subtotal, Graminoids	5.5	1.0	0.9	6.3	0.0	0.0	27.6	0.0	3.9	73.5	11.87	22
FORBS												
Cirsium arvense	1.4	0.0	2.0	0.0	0.0	0.0	T	0.0	0.3	0.0	0.37	0.68
Nepeta cataria	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.27	0.81
Subtotal, Forbs	4.1	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.64	1.3
TOTAL SPECIES	8	8	8	8	8	8	8	8	8	8	8	0
TOTAL WEIGHT	9.6	1.0	2.9	6.3	0.0	0.0	27.6	0.0	4.2	73.5	12.51	21.81
GRAMS/SQUARE METER	38.4	4.0	11.6	25.2	0.0	0.0	110.4	0.0	16.8	294.0	50.04	87.25
KILOGRAMS/HECTARE	384.0	40.0	116.0	252.0	0.0	0.0	1104.0	0.0	168.0	2940.0	500.4	872.51
POUNDS/ACRE	342.6	35.7	103.5	224.8	0.0	0.0	985.0	0.0	149.9	2623.1	446.46	778.45
OTHER SPECIES PRESENT												
Amorpha fruticosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.1	0.3
Salix exigua	0.0	0.0	0.0	1	13	1	0.0	8	1	2	2.6	4.15

T = trace amount

PRRIP91A.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Reference, 1991 (PRODWR91)

Study Site	MW01R	MW01R	MW01R	MW01R	MW01R	MW01R	MW01R	MW01R	MW01R	MW01R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	8.5	0.0	9.9	2.1	3.4	0.0	0.0	0.0	0.7	0.0	2.46	3.55
Agropyron smithii	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Bromus japonicus	T	0.0	1.7	0.0	0.0	0.0	0.0	0.6	1.2	1.6	0.51	0.68
Bromus tectorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0	0
Buchloe dactyloides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.4	0.28	0.72
Juncus balticus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	5.4	4.0	1.18	1.92
Poa compressa	0.0	16.4	0.5	18.9	6.8	38.0	4.8	0.9	1.4	4.0	9.17	11.48
Subtotal, Graminoids	9.1	16.4	12.1	21.0	10.2	38.0	4.8	3.9	11.1	10.0	13.66	9.4
FORBS												
Achillea millefolium	T	0.0	0.0	T	0.9	0.0	0.0	0.0	0.0	0.5	0.14	0.29
Alyssum minus	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.2
Ambrosia psilostachya	0.0	0.0	0.0	0.0	0.4	0.0	7.2	2.6	8.4	0.5	1.91	3.05
Artemesia ludoviciana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.23	0.69
Aster falcatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.06	0.18
Aster porteri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.31	0.93
Barbarea orthoceras	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.06	0.18
Centaurea repens	0.0	0.0	0.0	9.1	9.1	0.0	0.0	0.0	0.0	0.0	1.82	3.64
Conyza canadensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.06	0.18
Equisetum laevigatum	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.1	0.0	0.01	0.03
Geranium caespitosum	0.0	0.0	0.0	0.0	0.0	0.8	T	1.2	0.3	0.8	0.31	0.43
Heterotheca villosa	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.5	2.1	0.9	0.63	0.9
Hypericum perforatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.07	0.14
Lactuca serriola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.02	0.06
Melilotus officinalis	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Miscellaneous small forb	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Onosmodium molle	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0	0
Oxalis dillenii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.27	0.81
Solidago mollis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.0	9.4	1.19	2.78
Thermopsis divaricarpa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.09	0.27
Verbascum thapsus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.04	0.12
Subtotal, Forbs	0.0	0.7	0.5	9.1	10.4	0.8	8.0	13.6	13.4	17.4	7.39	6.14
TOTAL SPECIES	28	28	28	28	28	28	28	28	28	28	28	0
TOTAL WEIGHT	9.1	17.1	12.6	30.1	20.6	38.8	12.8	17.5	24.5	27.4	21.05	8.72
GRAMS/SQUARE METE	36.4	68.4	50.4	120.4	82.4	155.2	51.2	70.0	98.0	109.6	84.2	34.87
KILOGRAMS/HECTARE	364.0	684.0	504.0	1204.0	824.0	1552.0	512.0	700.0	980.0	1096.0	842	348.68
POUNDS/ACRE	324.8	610.3	449.7	1074.2	735.2	1384.7	456.8	624.5	874.4	977.9	751.23	311.09
OTHER SPECIES PRESENT												
Amorpha fruticosa	0.0	0.0	1	0.0	9	0.0	0.0	0.0	0.0	0.0	1	2.68
Salix exigua	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9
Symphoricarpos occident	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2

T = trace amount

PRODWR9 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Reference, 1991 (PRODWR91)

Study Site	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	02-Oct	mean	stdev
GRAMINOIDS												
Agropyron repens	2.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.28	0.6
Agropyron smithii	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Bromus japonicus	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.04
Carex nebraskensis	0.0	11.1	4.3	0.0	10.4	0.0	0.0	0.0	0.0	0.0	2.58	4.28
Juncus balticus	0.0	21.9	0.0	0.0	0.0	5.8	0.0	0.0	0.0	5.9	3.36	6.6
Juncus dudleyi	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16	0.48
Muhlenbergia racemosa	0.0	0.0	0.0	0.0	0.0	0.0	14.1	0.0	0.0	0.0	1.41	4.23
Poa compressa	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.4	0.0	0.0	0.32	0.73
Poa pratensis	0.0	0.1	0.0	0.0	0.4	0.9	0.4	0.0	0.0	0.0	0.18	0.29
Stipa comata	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.53	4.59
Subtotal, Graminoids	17.7	33.7	5.9	0.0	10.8	6.7	15.3	2.4	0.0	6.2	9.87	9.74
FORBS												
Ambrosia psilostachya	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.68	2.04
Barbarea orthoceras	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.42
Cirsium arvense	0.0	29.2	0.0	8.1	11.9	0.0	0.0	0.0	0.0	0.0	4.92	9.04
Conyza canadensis	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.03	0.06
Epilobium sp.	0.0	0.0	1.2	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.21	0.38
Equisetum laevigatum	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0	0
Geranium caespitosum	20.3	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.32	6.06
Gutierrezia sarothrae	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Mentha arvensis	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13	0.39
Miscellaneous small forb	0.0	0.1	1.3	0.0	0.1	0.0	0.6	0.0	T	0.0	0.21	0.4
Nepeta cataria	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Ranunculus macounii	0.0	7.6	0.0	2.2	0.9	4.8	0.0	0.0	0.0	0.0	1.55	2.5
Solidago mollis	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Subtotal, Forbs	20.6	36.9	5.2	10.3	13.2	5.4	7.9	2.9	0.0	0.0	10.24	10.7
TOTAL SPECIES	23	23	23	23	23	23	23	23	23	23	23	0
TOTAL WEIGHT	38.3	70.6	11.1	10.3	24.0	12.1	23.2	5.3	0.0	6.2	20.11	19.91
GRAMS/SQUARE METE	153.2	282.4	44.4	41.2	96.0	48.4	92.8	21.2	0.0	24.8	80.44	79.64
KILOGRAMS/HECTARE	1532.0	2824.0	444.0	412.0	960.0	484.0	928.0	212.0	0.0	248.0	804.4	796.35
POUNDS/ACRE	1366.9	2519.6	396.1	367.6	856.5	431.8	828.0	189.1	0.0	221.3	717.69	710.51
OTHER SPECIES PRESENT												
Amorpha fruticosa	0.0	3	0.0	1	0.0	0.0	0.0	7	0.0	0.0	1.1	2.17
Rhus aromatica	0.0	0.0	0.0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Salix exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0	0.1	0.3
Symphoricarpos occident	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.0	0.0	0.2	0.6

T = trace amount

PRODWR91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Riparian, Reference, 1991 (PRODWR91)

Study Site	MW03R	MW03R	MW03R	MW03R	MW03R	MW03R	MW03R	MW03R	MW03R	MW03R		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	18-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	0.0	0.0	0.7	1.2	0.9	0.5	0.5	0.4	0.0	0.3	0.45	0.38
Agropyron smithii	27.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.83	8.1
Bromus inermis	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.79	2.37
Bromus japonicus	1.4	0.7	0.0	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.31	0.45
Bromus tectorum	1.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.14	0.33
Carex stenophylla	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.76	2.28
Dactylis glomerata	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.16	0.33
Juncus balticus	0.0	0.0	8.2	0.0	0.0	0.0	0.5	0.0	0.0	1.4	1.01	2.43
Juncus dudleyi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.3	0.14	0.33
Muhlenbergia racemosa	0.0	0.0	0.0	0.0	0.0	0.0	4.7	9.9	33.0	0.0	4.76	9.91
Poa compressa	0.0	10.9	3.1	1.4	3.4	1.8	0.0	0.9	0.0	0.6	2.21	3.12
Subtotal, Graminoids	37.2	12.8	13.0	10.5	4.3	3.3	6.0	12.3	33.6	2.6	13.56	11.58
FORBS												
Alyssum minus	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.42
Aster ericoides	18.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.81	5.43
Barbarea orthoceras	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.02	0.06
Cirsium arvense	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.05	0.15
Geranium caespitosum	0.0	T	0.0	0.0	1.1	0.0	0.5	0.0	0.0	0.0	0.16	0.35
Lactuca serriola	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.36
Melilotus officinalis	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06	0.18
Mentha arvensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.07	0.21
Miscellaneous small forb	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.3	0.0	0.2	0.13	0.17
Potentilla gracilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.1	0.3
Solidago mollis	0.0	0.4	0.0	0.0	1.1	0.0	0.0	1.8	0.0	0.0	0.33	0.59
Sonchus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.02	0.06
Lycopus americanus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.14	0.42
Thermopsis divaricarpa	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Unidentified composite	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09
Unid. Forb 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.03	0.09
Verbascum thapsus	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.07	0.14
Viola sp.	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Subtotal, Forbs	20.7	1.7	0.0	0.0	2.5	1.3	1.1	4.1	0.0	1.8	3.32	5.92
TOTAL SPECIES	29	29	29	29	29	29	29	29	29	29	29	0
TOTAL WEIGHT	57.9	14.5	13.0	10.5	6.8	4.6	7.1	16.4	33.6	4.4	16.88	15.9
GRAMS/SQUARE METE	231.6	58.0	52.0	42.0	27.2	18.4	28.4	65.6	134.4	17.6	67.52	63.59
KILOGRAMS/HECTARE	2316.0	580.0	520.0	420.0	272.0	184.0	284.0	656.0	1344.0	176.0	675.2	635.94
POUNDS/ACRE	2066.3	517.5	463.9	374.7	242.7	164.2	253.4	585.3	1199.1	157.0	602.41	567.39
OTHER SPECIES PRESENT												
Amorpha fruticosa	0.0	0.0	2	0.0	0.0	0.0	8	2	0.0	0.0	1.2	2.4
Crataegus erythropoda	0.0	0.0	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2
Rosa woodsii	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2
Salix exigua	0.0	0.0	0.0	0.0	0.0	0.0	3	0.0	0.0	0.0	0.3	0.9

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Reclaimed, Study, 1991 (PRODRA91)

Study Site	MR01A	MR01A	MR01A	MR01A	MR01A	MR01A	MR01A	MR01A	MR01A	MR01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	mean	stdev
GRAMINOIDS												
Agropyron desertorum	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2
Agropyron intermedium	71.3	37.6	16.1	21.2	1.8	1.9	0.0	0.0	0.0	0.0	14.99	22.28
Agropyron repens	0.0	0.0	0.0	0.0	0.0	2.9	8.0	0.0	0.0	6.5	1.74	2.9
Agropyron smithii	0.0	0.0	0.0	0.0	0.0	0.0	21.2	33.6	50.6	0.0	10.54	17.4
Bromus inermis	0.8	14.6	7.3	0.4	21.3	7.8	1.1	T	8.1	53.7	11.51	15.52
Poa pratensis	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.58	1.74
Schedonnardus paniculatus	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.67	2.01
Stipa viridula	0.0	25.4	0.0	0.0	0.0	0.0	0.0	13.6	0.0	0.0	3.9	8.23
Subtotal, Graminoids	72.1	77.6	23.4	21.6	27.1	18.4	37.0	47.2	58.7	60.2	44.33	20.79
FORBS												
Alyssum minus	0.0	0.0	0.0	0.0	T	0.0	0.6	0.4	0.0	0.0	0.1	0.2
Ambrosia psilostachya	0.0	0.0	0.0	0.0	0.0	1.2	1.1	0.0	0.0	0.0	0.23	0.46
Cirsium avensis	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Melilotus officinalis	0.0	0.0	2.9	5.1	0.4	2.6	3.4	7.5	0.0	0.0	2.19	2.47
Subtotal, Forbs	0.0	0.0	2.9	5.1	0.4	3.8	5.1	7.9	0.0	0.0	2.52	2.72
TOTAL SPECIES	12	12	12	12	12	12	12	12	12	12	12	0
TOTAL WEIGHT	72.1	77.6	26.3	26.7	27.5	22.2	42.1	55.1	58.7	60.2	46.85	19.5
GRAMS/SQUARE METER	288.4	310.4	105.2	106.8	110.0	88.8	168.4	220.4	234.8	240.8	187.4	78
KILOGRAMS/HECTARE	2884.0	3104.0	1052.0	1068.0	1100.0	888.0	1684.0	2204.0	2348.0	2408.0	1874	780.03
POUNDS/ACRE	2573.1	2769.4	938.6	952.9	981.4	792.3	1502.5	1966.4	2094.9	2148.4	1671.98	695.94

T = trace amount

PRODRA91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Reclaimed, Study, 1991 (PRODRA91)

Study Site	MR03A	MR03A	MR03A	MR03A	MR03A	MR03A	MR03A	MR03A	MR03A	MR03A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	05-Sep	mean	stdev
GRAMINOIDS												
Bromus inermis	55.6	57.1	54.1	47.6	34.6	58.3	45.6	45.5	59.4	28.7	48.65	9.87
Subtotal, Graminoids	55.6	57.1	54.1	47.6	34.6	58.3	45.6	45.5	59.4	28.7	48.65	9.87
FORBS												
Convolvulus arvensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.18	0.54
Subtotal, Forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.18	0.54
TOTAL SPECIES	2	2	2	2	2	2	2	2	2	2	2	0
TOTAL WEIGHT	55.6	57.1	54.1	47.6	34.6	58.3	45.6	45.5	61.2	28.7	48.83	10.08
GRAMS/SQUARE METER	222.4	228.4	216.4	190.4	138.4	233.2	182.4	182.0	244.8	114.8	195.32	40.31
KILOGRAMS/HECTARE	2224.0	2284.0	2164.0	1904.0	1384.0	2332.0	1824.0	1820.0	2448.0	1148.0	1953.2	403.08
POUNDS/ACRE	1984.3	2037.8	1930.7	1698.7	1234.8	2080.6	1627.4	1623.8	2184.1	1024.2	1742.65	359.62

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Disturbed, Study, 1991 (PRODDA91)

Study Site	MD01A	MD01A	MD01A	MD01A	MD01A	MD01A	MD01A	MD01A	MD01A	MD01A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	17-Sep	mean	stdev
GRAMINOIDS												
Agropyron repens	T	8.1	0.0	0.0	0.0	3.3	1.5	0.0	0.0	0.0	1.29	2.49
Bromus inermis	0.5	8.3	6.7	26.5	34.3	2.6	0.0	28.4	39.2	41.1	18.76	15.85
Bromus japonicus	5.5	T	1.0	0.0	0.0	2.3	1.8	0.0	0.0	0.0	1.06	1.69
Bromus tectorum	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.12	0.36
Subtotal, Graminoids	6.0	16.4	7.7	26.5	34.3	9.4	3.3	28.4	39.2	41.1	21.23	13.67
FORBS												
Ambrosia psilostachya	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.21
Centaurea diffusa	0.0	7.2	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.77	3.62
Chenopodium leptophyllum	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.0	0.0	0.0	0.13	0.26
Cirsium arvense	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.19	3.57
Convolvulus arvensis	5.1	0.0	0.0	0.0	0.0	1.6	0.0	0.0	T	0.1	0.68	1.55
Lactuca serriola	2.9	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.41	0.9
Melilotus officinalis	9.5	7.7	20.5	25.1	4.3	1.9	1.3	0.7	0.8	0.1	7.19	8.41
Salsola iberica	0.0	0.0	0.0	0.0	0.0	1.6	4.9	0.4	0.0	0.0	0.69	1.48
Subtotal, Forbs	29.4	14.9	31.7	26.3	4.3	5.8	6.8	1.1	0.8	0.2	12.13	11.88
TOTAL SPECIES	12	12	12	12	12	12	12	12	12	12	12	0
TOTAL WEIGHT	35.4	31.3	39.4	52.8	38.6	15.2	10.1	29.5	40.0	41.3	33.36	12.01
GRAMS/SQUARE METER	141.6	125.2	157.6	211.2	154.4	60.8	40.4	118.0	160.0	165.2	133.44	48.05
KILOGRAMS/HECTARE	1416.0	1252.0	1576.0	2112.0	1544.0	608.0	404.0	1180.0	1600.0	1652.0	1334.4	480.52
POUNDS/ACRE	1263.4	1117.0	1406.1	1884.3	1377.6	542.5	360.4	1052.8	1427.5	1473.9	1190.55	428.72

T = trace amount

PRODDA91.XLS 8/10/93

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Disturbed, Study, 1991 (PRODDA91)

Study Site	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A		
Plot	1	2	3	4	5	6	7	8	9	10		
Date	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	07-Oct	mean	stdev
GRAMINOIDS												
Agropyron smithii	0.0	0.0	0.0	0.0	7.6	0.0	15.0	0.0	0.0	3.0	2.56	4.76
Bromus inermis	37.8	35.4	16.0	12.3	6.5	37.5	0.4	0.5	0.0	8.1	15.45	14.89
Bromus japonicus	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	1.4	0.27	0.54
B. japonicus & tectorum	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Poa pratensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	9.8	0.0	2.32	4.71
Subtotal, Graminoids	37.8	35.4	16.0	12.3	14.5	37.5	16.7	13.9	9.8	12.5	20.64	10.82
FORBS												
Centaurea repens	0.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0	0.0	0.0	1.14	3.42
Chenopodium leptophyllum	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03
Cirsium arvense	0.0	0.0	0.0	0.9	17.0	0.0	6.8	10.3	6.0	1.6	4.26	5.47
Convolvulus arvensis	1.3	1.4	2.1	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.58	0.73
Melilotus officinalis	0.0	0.2	2.0	2.1	7.2	8.7	11.2	24.4	27.6	6.2	8.96	9.24
Miscellaneous small forbs	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Salsola iberica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Subtotal, Forbs	1.3	1.6	4.1	3.9	24.6	8.7	29.4	34.7	33.6	7.8	14.97	13.17
TOTAL SPECIES	12	12	12	12	12	12	12	12	12	12	12	0
TOTAL WEIGHT	39.1	37.0	20.1	16.2	39.1	46.2	46.1	48.6	43.4	20.3	35.61	11.53
GRAMS/SQUARE METER	156.4	148.0	80.4	64.8	156.4	184.8	184.4	194.4	173.6	81.2	142.44	46.12
KILOGRAMS/HECTARE	1564.0	1480.0	804.0	648.0	1564.0	1848.0	1844.0	1944.0	1736.0	812.0	1424.4	461.23
POUNDS/ACRE	1395.4	1320.5	717.3	578.1	1395.4	1648.8	1645.2	1734.4	1548.9	724.5	1270.85	411.51

T = trace amount

PRODUCTION PLOT SUMMARY FORM (grams/0.25 square meters)
HABITAT TYPE: Disturbed, Study, 1991 (PRODDA91)

Study Site	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A	MD02A		
Plot	11	12	13	14	15	16	17	18	19	20		
Date	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	16-Sep	mean	stdev
GRAMINOIDS												
Agropyron cristatum	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.1
Agropyron intermedium	0.0	19.4	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	1.94	5.82
Bromus inermis	0.0	0.0	40.2	24.0	67.5	27.2	8.5	38.8	29.3	49.1	28.46	20.58
Ehcinochloa crusgallii	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.12
Sporobolus cryptandrus	28.6	2.5	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	3.11	8.53
Subtotal, Graminoids	29.0	21.9	40.2	31.0	67.5	27.2	8.5	38.8	29.3	49.1	34.25	15.2
FORBS												
Ambrosia psilostachya	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.35	1.05
Convolvulus arvensis	0.0	0.3	0.0	1.0	0.0	0.0	0.6	0.0	0.0	0.0	0.19	0.33
Conyza canadensis	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Dyssodia papposa	1.7	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.17	0.51
Grindelia squarrosa	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.04	0.12
Lactuca serriola	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.62	1.86
Melilotus officinalis	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.06
Miscellaneous small forbs	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Subtotal, Forbs	5.2	0.3	0.0	1.2	0.0	0.0	7.2	0.0	0.0	0.0	1.39	2.47
TOTAL SPECIES	13	13	13	13	13	13	13	13	13	13	13	0
TOTAL WEIGHT	34.2	22.2	40.2	32.2	67.5	27.2	15.7	38.8	29.3	49.1	35.64	13.89
GRAMS/SQUARE METER	136.8	88.8	160.8	128.8	270.0	108.8	62.8	155.2	117.2	196.4	142.56	55.58
KILOGRAMS/HECTARE	1368.0	888.0	1608.0	1288.0	2700.0	1088.0	628.0	1552.0	1172.0	1964.0	1425.6	555.78
POUNDS/ACRE	1220.5	792.3	1434.7	1149.2	2408.9	970.7	560.3	1384.7	1045.7	1752.3	1271.92	495.87

T = trace amount

PRODDA91.XLS 8/10/93

E-2-3: Benthic Invertebrate Data

BENTHIC INVERTEBRATE DATA
OU1
SITE: SW039
SAMPLED: 6-17-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis quilleri	0	0	0	1	0	0
Baetis tricaudatus	32	40	4	32	20	26
Nixe criddlei	5	12	0	1	16	7
ODONATA						
Argia sp.	1	0	0	1	0	0
TRICHOPTERA						
Glossosomatidae G. sp.	4	0	0	0	0	1
COLEOPTERA						
Agabus sp.	0	0	0	0	4	1
Optioservus sp.	0	4	0	0	0	1
DIPTERA						
Chironomidae pupae	0	0	12	0	0	2
Cricotopus (Isocladius) sp.	0	0	0	8	4	2
Eukiefferiella sp.	12	4	8	0	0	5
Limnophora sp.	0	0	0	0	4	1
Orthocladius (Orthocladius)	16	16	136	12	28	42
Paratrichocladius sp.	0	0	0	12	0	2
Simulium sp.	132	56	0	0	20	42
Synorthocladius sp.	8	0	8	0	0	3
Thienemanniella sp.	0	4	0	0	0	1
Thienemannimyia sp. grp.	4	0	0	0	4	2
Unidentifiable Chironomidae	16	0	0	4	0	4
OLIGOCHAETA						
OLIGOCHAETA	2	4	8	0	0	3
GASTROPODA						
Gyraulus sp.	1	0	0	0	0	0
TOTAL (#/sample)	233	140	176	71	100	144
NUMBER OF TAXA	11	8	5	7	8	18
SHANNON-WEAVER (H')	2.00	2.29	0.99	2.04	2.61	2.66

BENTHIC INVERTEBRATE DATA
OU1
SITE: SW-33
SAMPLED: 6-14-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis tricaudatus	8	0	3	21	16	10
Nixe simplicoides	0	2	2	2	4	2
Tricorythodes minutus	0	0	1	0	0	0
ODONATA						
Argia sp.	0	0	0	0	8	2
Enallagma ap.	0	0	0	2	0	0
TRICHOPTERA						
Cheumatopsyche sp.	0	0	0	0	8	2
Helicopsyche borealis	4	6	2	6	0	4
Hydropsyche sp.	0	1	0	7	0	2
Limnephilus sp.	0	0	2	1	0	1
DIPTERA						
Chironomidae (pupae)	0	0	0	0	4	1
Corynoneura sp.	0	0	0	0	4	1
Cricotopus (Isocladius) sp.	16	0	50	0	16	16
Dicrotendipes sp.	0	2	20	0	0	4
Eukiefferiella sp.	0	0	10	0	8	4
Orthocladius (Eudactylocladius) sp.	20	1	0	0	0	4
Orthocladius (Orthocladius) sp.	60	21	210	0	44	67
Thienemanniella sp.	0	0	0	0	4	1
Unidentifiable Chironomidae	0	0	0	0	24	5
AMPHIPODA						
Hyallela azteca	0	0	0	0	4	1
GASTROPODA						
Physella sp.	4	2	3	1	8	4
TOTAL (#/sample)	112	35	303	40	152	128
NUMBER OF TAXA	6	7	10	7	11	18
SHANNON-WEAVER (H')	1.94	1.88	1.52	2.04	2.95	2.50

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI3
SAMPLED: 6-13-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis flavistriga	4	4	16	4	2	6
Baetis quilleri	8	8	20	4	1	8
Baetis tricaudatus	4	0	16	24	5	10
Caenis sp.	0	4	8	8	3	5
Nixe criddlei	4	0	0	8	0	2
Tricorythodes minutus	4	0	4	4	0	2
ODONATA						
Argia sp.	0	0	0	4	1	1
Enallagma sp.	0	4	8	12	1	5
TRICHOPTERA						
Cheumatopsyche sp.	0	0	0	0	1	0
Helicopsyche sp.	0	0	4	0	0	1
Hydroptila sp.	0	0	0	0	1	0
Leptoceridae G. sp.	0	0	0	0	1	0
Limnephilidae G. sp.	4	0	0	0	0	1
DIPTERA						
Cricotopus trifascia sp.	0	0	4	0	0	1
Cryptochironomus sp.	0	0	4	0	0	1
Dicrotendipes sp.	0	0	0	0	1	0
Orthocladius (Orthocladius)	0	0	4	0	0	1
Polypedilum (Tripodura) sp.	0	0	0	4	0	1
Rheotanytarsus sp.	0	0	12	0	2	3
Simulium sp.	0	0	4	0	5	2
Thienemanniella sp.	0	0	4	0	0	1
Thienemannimyia sp. grp.	0	0	0	4	0	1
Tipula sp.	0	2	4	20	1	5
OLIGOCHAETA						
OLIGOCHAETA	32	32	12	12	5	19

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI3
SAMPLED: 6-13-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
CRUSTACEA						
AMPHIPODA						
Hyalella azteca	0	4	16	12	0	6
DECAPODA						
Cambaridae G. sp.	0	0	0	4	0	1
HYDRACARINA						
HYDRACARINA	0	4	0	0	0	1
GASTROPODA						
Physella sp.	0	8	4	0	0	2
PELECYPODA						
Sphaerium sp.	0	4	12	0	0	3
TOTAL (#/sample)	60	74	156	124	30	89
NUMBER OF TAXA	29	29	29	29	29	29
SHANNON-WEAVER (H')	2.17	2.72	3.90	3.49	3.45	4.01

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI1
SAMPLED: 6-12-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis bicaudatus	0	0	4	0	0	1
Baetis quilleri	20	12	29	30	56	29
Caenis sp.	2	2	1	0	0	1
Centroptilum sp.	0	0	0	0	26	5
Leptophlebia sp.	0	0	0	0	4	1
Nixe simplicoides	4	1	0	0	0	1
Paraleptophlebia sp.	1	0	0	0	0	0
ODONATA						
Argia sp.	0	1	3	6	2	2
TRICHOPTERA						
Hydropsyche alhedra	4	3	4	16	0	5
Hydropsyche amblis	0	0	0	0	36	7
Ochrotrichia sp.	0	1	3	2	6	2
COLEOPTERA						
Hydaticus sp.	0	0	1	0	0	0
DIPTERA						
Cricotopus trifascia sp.	0	8	0	6	8	4
Cricotopus (Isocladius) sp.	14	24	12	8	16	15
Eukiefferiella sp.	0	4	6	14	32	11
Hemerodromia sp.	0	0	1	0	0	0
Orthocladius (Orthocladius)	32	22	14	16	40	25
Paratanytarsus sp.	4	0	0	0	0	1
Rheotanytarsus sp.	0	2	2	0	0	1
Simulium sp.	1	0	11	12	80	21
Thienemanniella sp.	0	0	0	0	4	1
Thienemannimyia sp. grp.	0	2	2	0	8	2
Unidentifiable Chironomidae	0	0	0	4	0	1
HYDRACARINA						
HYDRACARINA	0	0	2	0	0	0
AMPHIPODA						
Hyallela azteca	2	0	0	0	0	0
GASTROPODA						
Physella sp.	4	6	2	0	0	2
TOTAL (#/sample)	88	88	97	114	318	141
NUMBER OF TAXA	11	13	16	9	13	25
SHANNON-WEAVER (H')	2.64	2.94	3.26	2.89	3.10	3.50

BENTHIC INVERTEBRATE DATA
OU1
SITE: SWC1
SAMPLED: 5-30-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
DIPTERA						
Chironomus (Chironomus)	2	0	0	2	0	2
Cryptochironomus sp.	7	2	0	0	0	2
Procladius sp.	19	2	2	64	0	13
Tanypus sp.	13	0	7	19	0	7
Tanytarsus sp.	0	0	0	2	0	1
OLIGOCHAETA						
OLIGOCHAETA	81	0	89	220	0	42
TOTAL (#/sample)	123	5	99	308	0	66
NUMBER OF TAXA	6	6	6	6	6	6
SHANNON-WEAVER (H')	1.83	1.00	0.87	1.48		1.61

BENTHIC INVERTEBRATE DATA
OU1
SITE: SW039
SAMPLED: 9-13-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis quilleri	0	0	0	1	0	0
Caenis sp.	81	363	0	7	16	47
Paraleptophlebia sp.	26	13	0	0	14	9
ODONATA						
Argia sp.	2	13	1	0	0	4
TRICHOPTERA						
Cheumatopsyche sp.	0	0	46	1	0	7
Oecetis sp.	0	0	1	1	0	1
DIPTERA						
Brillia sp.	2	0	0	0	0	1
Cricotopus trifascia sp.	2	0	0	0	0	1
Dicrotendipes sp.	2	0	0	0	0	1
Eukiefferiella sp.	0	0	0	0	0	0
Pericoma sp.	0	0	0	1	0	0
Phaenopsectra sp.	0	0	0	0	1	0
Tanytarsus sp.	7	200	1	1	7	24
Thienemannimyia sp. grp.	2	13	1	0	5	5
Tipula sp.	0	0	0	2	0	1
Zavrelimyia sp.	0	2	0	0	0	1
OLIGOCHAETA						
OLIGOCHAETA	7	0	0	0	3	3
CRUSTACEA						
AMPHIPODA						
Hyalella azteca	0	0	0	0	0	0
GASTROPODA						
Physella sp.	0	0	0	0	1	0
TOTAL (#/sample)	133	604	50	13	47	105
NUMBER OF TAXA	19	19	19	19	19	19
SHANNON-WEAVER (H')	2.45	1.64	1.54	2.55	2.77	2.57

BENTHIC INVERTEBRATE DATA
OU1
SITE: SWO33
SAMPLED: 10-3-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
PLECOPTERA						
Isoperla sp.	0	8	0	0	0	2
EPHEMEROPTERA						
Baetis bicaudatus	0	20	0	0	0	4
Baetis quilleri	0	68	12	1	0	16
Caenis sp.	60	80	408	73	184	161
Paraleptophlebia sp.	0	0	0	4	2	1
Tricorythodes minutus	58	16	112	125	64	75
ODONATA						
Argia sp.	0	28	72	7	12	24
TRICHOPTERA						
Helicopsyche borealis	4	20	36	7	0	13
Hydropsyche alhedra	0	132	32	8	0	34
Ochrotrichia sp.	2	0	0	5	0	1
Oecetis sp.	2	0	12	3	0	3
COLEOPTERA						
Hydaticus sp.	0	0	4	0	2	1
Rhizelmis sp.	2	8	4	0	4	4
DIPTERA						
Apsectrotanypus sp.	0	0	16	0	0	3
Bezzia sp.	0	4	8	1	0	3
Brillia sp.	0	4	0	0	0	1
Chaetocladius sp.	0	0	0	0	4	1
Chironomus (Chironomus) s	0	0	12	0	0	2
Corynoneura sp.	0	0	0	1	0	0
Cricotopus trifascia sp.	2	0	0	0	0	0
Cryptochironomus sp.	6	4	0	0	0	2
Eukiefferiella sp.	0	8	0	0	0	2
Hemerodromia sp.	2	0	0	2	0	1
Orthocladius (Orthocladius)	0	0	0	1	0	0
Pseudolimnophila sp.	0	8	4	8	16	7
Simulium sp.	0	148	32	1	0	36
Tanytarsus sp.	0	4	4	9	8	5
Thienemanniella sp.	2	0	0	0	0	0
Thienemannimyia sp. grp.	2	0	20	12	24	12
Unidentifiable Chironomidae	0	0	0	5	0	1

BENTHIC INVERTEBRATE DATA
OU1
SITE: SWO33
SAMPLED: 10-3-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
OLIGOCHAETA						
OLIGOCHAETA	0	8	20	3	0	6
AMPHIPODA						
Hyallela azteca	0	0	4	5	4	3
GASTROPODA						
Physella sp.	2	28	68	5	20	25
PELECYPODA						
Sphaerium sp.	0	0	8	0	0	2
TOTAL (#/sample)	144	596	888	286	344	452
NUMBER OF TAXA	12	18	20	20	12	33
SHANNON-WEAVER (H')	2.07	3.22	2.90	2.67	2.25	3.32

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI3
SAMPLED: 9-13-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis flavistriga	0	1	0	0	0	0
Baetis quilleri	0	2	4	0	0	1
Caenis sp.	12	2	48	2	1	13
Ephemerella sp.	0	0	0	1	0	0
Paraleptophlebia sp.	2	0	4	0	0	1
Tricorythodes sp.	0	1	0	1	5	1
ODONATA						
Argia sp.	0	0	16	1	1	4
TRICHOPTERA						
Cheumatopsyche sp.	0	0	4	0	0	1
Helicopsyche sp.	0	0	0	1	0	0
Stactobiella sp.	0	0	0	2	0	0
COLEOPTERA						
Dytiscidae G. sp.	2	0	0	0	0	0
Optioservus sp.	0	0	0	1	0	0
DIPTERA						
Dicrotendipes sp.	0	0	0	0	1	0
Paratrichocladius sp.	2	0	0	0	0	0
Procladius sp.	0	0	0	0	1	0
Thienemannimyia sp. grp.	0	3	0	1	1	1
Unidentifiable Chironomid	0	0	36	0	0	7
OLIGOCHAETA						
OLIGOCHAETA	3	8	52	30	4	19
HIRUDINEA						
Mooreobdella microstoma	0	0	0	1	1	0
CRUSTACEA						
AMPHIPODA						
Hyalella azteca	4	1	12	0	4	4
GASTROPODA						
Physella sp.	2	0	0	0	2	1
PELECYPODA						
Sphaerium sp.	0	2	0	0	1	1
TOTAL (#/sample)	27	20	176	41	22	57
NUMBER OF TAXA	7	8	7	10	11	21
SHANNON-WEAVER (H')	2.39	2.58	2.16	1.67	3.11	2.81

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI1
SAMPLED: 10-3-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Baetis quilleri	2	0	8	2	0	2
Caenis sp.	36	0	16	13	128	39
Paraleptophlebia sp.	6	60	2	3	8	16
Tricorythodes minutus	10	2	0	0	8	4
ODONATA						
Argia sp.	4	6	32	3	18	13
TRICHOPTERA						
Helicopsyche borealis	0	0	0	0	4	1
Hydropsyche alhedra	2	0	14	1	0	3
Leucotrichia sp.	0	2	0	0	0	0
Ochrotrichia sp.	2	4	6	0	0	2
Oecetis sp.	2	0	0	0	2	1
COLEOPTERA						
Hydaticus sp.	0	8	6	0	0	3
Rhizelmis sp.	0	2	0	0	0	0
DIPTERA						
Ablabesmyia sp.	0	4	0	0	0	1
Bezzia sp.	0	0	2	1	4	1
Cricotopus trifascia sp.	12	0	12	6	8	8
Cricotopus (Isocladius) sp.	28	4	20	2	40	19
Hemerodromia sp.	0	0	10	2	2	3
Nanocladius sp.	0	0	4	0	0	1
Orthocladius (Orthocladius)	12	0	32	2	56	20
Pseudolimnophila sp.	0	0	4	0	0	1
Rheotanytarsus sp.	0	4	0	0	0	1
Simulium sp.	0	0	22	7	6	7
Stratiomys sp.	0	0	0	1	0	0
Tanytarsus sp.	8	16	4	2	0	6
Thienemannimyia sp. grp.	28	72	12	24	48	37
Unidentifiable Chironomidae	8	4	0	0	0	2
HYDRCARINA						
HYDRACARINA	0	2	2	0	0	1

BENTHIC INVERTEBRATE DATA
OU1
SITE: WORI1
SAMPLED: 10-3-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
AMPHIPODA						
Hyallela azteca	12	52	8	5	20	19
GASTROPODA						
Physella sp.	12	8	18	14	20	14
PELECYPODA						
Sphaerium sp.	0	2	0	0	0	0
TOTAL (#/sample)	184	252	234	88	372	226
NUMBER OF TAXA	15	16	20	16	15	29
SHANNON-WEAVER (H')	3.39	2.86	3.92	3.30	3.01	3.81

BENTHIC INVERTEBRATE DATA
OU1
SITE: SWC01
SAMPLED: 10-02-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
EPHEMEROPTERA						
Caenis sp.	0	0	1	0	0	0
DIPTERA						
Bezzia sp.	0	0	5	2	0	2
Chaoborus albips	0	7	0	0	0	2
Chironomidae (pupae)	0	2	0	0	0	1
Chironomus (Chironomus) sp.	89	230	10	1139	107	133
Einfeldia sp.	0	0	0	0	19	3
Orthocladius (Orthocladius) sp.	0	0	1	19	0	4
Procladius sp.	0	7	1	116	0	15
Simulium sp.	0	2	1	0	0	1
Tanypus sp.	7	48	44	48	0	20
Unidentifiable Chironomidae	19	7	0	0	0	5
OLIGOCHAETA						
OLIGOCHAETA	1114	1237	651	1004	60	316
TOTAL (#/sample)	1230	1541	712	2328	186	503
NUMBER OF TAXA	10	10	10	10	10	10
SHANNON-WEAVER (H')	0.61	1.19	0.98	1.61	1.47	1.45

BENTHIC INVERTEBRATE DATA
OU1
SITE: SWC2
SAMPLED: 5-31-91

TAXA	SAMPLE 1	2	3	4	5	COMPOSITE DENSITY
INSECTA						
HEMIPTERA						
Corixidae G. sp.	0	0	41	0	0	6
Trichocorixa sp.	0	0	7	0	0	2
DIPTERA						
Chaoborus albipes	37	0	0	0	6	7
Chironomidae (pupae)	0	0	2	0	0	1
Chironomus (Chironomus) sp.	89	48	48	19	52	33
Cladotanytarsus sp.	0	0	7	0	0	2
Cryptochironomus sp.	0	0	7	0	0	2
Dicrotendipes sp.	0	0	0	2	0	1
Endochironomus sp.	0	0	2	0	0	1
Glypotendipes sp.	0	13	0	0	0	2
Microtendipes sp.	0	0	2	0	0	1
Orthocladius (Orthocladius) sp.	0	0	2	0	0	1
Parachironomus sp.	0	0	0	2	0	1
Paratanytarsus sp.	0	2	0	0	0	1
Polypedilum (Polypedilum)	0	0	7	0	0	2
Procladius sp.	0	0	2	33	1	6
Tanypus sp.	0	56	0	13	0	10
OLIGOCHAETA						
OLIGOCHAETA	5	200	13	171	2	42
TOTAL (#/sample)	131	320	143	241	61	118
NUMBER OF TAXA	17	17	17	17	17	17
SHANNON-WEAVER (H')	1.22	1.75	3.03	1.79	1.24	2.76

ATTACHMENT E-3

TISSUE DATA

TISSUE ANALYSIS FROM RFP 1991*

KEY

SPECIES CODE	COMMON NAME	SCIENTIFIC NAME	SUBTYPE CODE
ACRI	GRASSHOPPER	ACRIDIDAE	AV = BIRDS
AMTI	TIGER SALAMANDER	AMBYSTOMA TIGRINUM	BM = BENTHIC MACROINVERTEBRATES
ARLU	WHITE SAGE	ARTEMISIA LUDOVICIANA	FI = FISH
ASFA	ASTER	ASTER FALCATUS	HE = HERPTILES
BOGR	BLUE GRAMA	BOUTELOUA GRACILIS	SM = SMALL MAMMALS
BRCA	CANADA GOOSE	BRANTA CANADENSIS	TA = TERRESTRIAL ARTHROPODS
BRIN	SMOOTH BROME	BROMUS INERMIS	VE = VEGETATION
CACO	WHITE SUCKER	CATOSTOMUS COMMERSONI	
CRAYF	CRAYFISH		
LECY	GREEN SUNFISH	LEPOMIS CYANELLUS	
MEOF	SWEET CLOVER	MELILOTUS OFFICINALE	
MIPE	MEADOW VOLE	MICROTUS PENNSYLVANICUS	
MISA	LARGEMOUTH BASS	MICROPTERUS SALMOIDES	
NOCR	GOLDEN SHINER	NOTEMIGONUS CRYSOLEUCAS	
PEMA	DEER MOUSE	PEROMYSCUS MANICULATUS	
PIPR	FATHEAD MINNOW	PIMEPHALES PROMELAS	
POCO	CANADA BLUEGRASS	POA COMPRESSA	
SEAT	CREEK CHUB	SEMOTILUS ATROMACULATUS	
THRA	PLAINS GARTER SNAKE	THAMNOPHIS RADIX	

SHIP.WK1 03-Jun-92 trrEED

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Cadmium	3.700	MG/KG	
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Chromium	4.500	MG/KG	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Copper	13.800	MG/KG	
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Lead	1.500	MG/KG	UI
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Mercury	0.700	MG/KG	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Selenium	6.000	MG/KG	UI
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Silver	3.000	MG/KG	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Zinc	89.900	MG/KG	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Cadmium	2.700	MG/KG	U
BM	CRAYF	AQUATIC	SW038	BI00501EB	Chromium	5.600	MG/KG	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Copper	122.000	MG/KG	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Lead	5.200	MG/KG	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Mercury	0.600	MG/KG	U
BM	CRAYF	AQUATIC	SW038	BI00501EB	Selenium	5.500	MG/KG	UI
BM	CRAYF	AQUATIC	SW038	BI00501EB	Silver	2.700	MG/KG	U
BM	CRAYF	AQUATIC	SW038	BI00501EB	Zinc	219.000	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Cadmium	5.200	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Chromium	7.700	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Copper	99.700	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Lead	10.100	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Mercury	1.100	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Selenium	10.300	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Silver	5.200	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Zinc	301.000	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Cadmium	5.200	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Chromium	15.100	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Copper	604.000	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Lead	12.700	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Mercury	1.200	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Silver	5.200	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Zinc	406.000	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Cadmium	3.000	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Chromium	4.700	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Copper	118.000	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Lead	4.100	MG/KG	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Mercury	0.700	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Selenium	6.100	MG/KG	UI
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Silver	3.000	MG/KG	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Zinc	126.000	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Cadmium	3.100	MG/KG	U
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Chromium	4.900	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Copper	516.000	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Lead	5.600	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Mercury	0.600	MG/KG	U
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Selenium	6.100	MG/KG	UI
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Silver	3.100	MG/KG	U
BM	CRAYF	AQUATIC	WOPO002	BI00496EB	Zinc	203.000	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Cadmium	2.600	MG/KG	U
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Chromium	5.800	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Copper	135.000	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Lead	4.000	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Mercury	0.600	MG/KG	U
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Selenium	5.100	MG/KG	UI
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Silver	3.300	MG/KG	
BM	CRAYF	AQUATIC	WOPO002	BI00497EB	Zinc	145.000	MG/KG	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Cadmium	3.600	MG/KG	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Chromium	17.900	MG/KG	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Copper	804.000	MG/KG	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Lead	11.400	MG/KG	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Mercury	1.700	MG/KG	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Selenium	14.300	MG/KG	UI
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Silver	10.700	MG/KG	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Zinc	375.000	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00475EB	Cadmium	1.400	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Chromium	7.200	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Copper	16.500	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00475EB	Lead	3.000	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00475EB	Mercury	0.700	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	CACO1	AQUATIC	SW026	BI00475EB	Selenium	7.000	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00475EB	Silver	4.300	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Zinc	90.000	MG/KG	-
FI	CACO1	AQUATIC	SW026	BI00476EB	Cadmium	2.500	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00476EB	Chromium	12.600	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00476EB	Copper	12.400	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00476EB	Lead	3.200	MG/KG	
FI	CACO1	AQUATIC	SW026	BI00476EB	Mercury	1.300	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00476EB	Selenium	10.100	MG/KG	UI
FI	CACO1	AQUATIC	SW026	BI00476EB	Silver	7.500	MG/KG	U
FI	CACO1	AQUATIC	SW026	BI00476EB	Zinc	300.000	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00215EB	Cadmium	1.400	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Chromium	2.100	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Copper	1.400	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Lead	1.400	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00215EB	Mercury	0.300	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Selenium	3.000	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00215EB	Silver	1.400	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Zinc	40.500	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Cadmium	1.300	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Chromium	2.400	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Copper	5.900	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Lead	1.000	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Mercury	0.300	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Selenium	2.700	MG/KG	UI
FI	CACO1	AQUATIC	SWC001	BI00216EB	Silver	1.300	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Zinc	44.500	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Cadmium	1.400	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Chromium	3.100	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Copper	3.500	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Lead	1.700	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Mercury	0.300	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Selenium	21.300	MG/KG	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Silver	1.400	MG/KG	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Zinc	62.100	MG/KG	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Cadmium	3.400	MG/KG	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Chromium	17.200	MG/KG	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Copper	115.000	MG/KG	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Lead	4.400	MG/KG	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Mercury	1.700	MG/KG	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Selenium	14.300	MG/KG	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Silver	10.300	MG/KG	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Zinc	120.000	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00489EB	Cadmium	1.100	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Chromium	5.700	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Copper	14.000	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00489EB	Lead	1.300	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00489EB	Mercury	0.500	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Selenium	4.600	MG/KG	UI
FI	CACO1	AQUATIC	WORI01	BI00489EB	Silver	3.400	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Zinc	126.000	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00490EB	Cadmium	0.900	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Chromium	4.900	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Copper	3.900	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Lead	1.500	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00490EB	Mercury	0.400	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Selenium	3.900	MG/KG	UI
FI	CACO1	AQUATIC	WORI01	BI00490EB	Silver	2.900	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Zinc	85.400	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00491EB	Cadmium	1.000	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Chromium	5.000	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Copper	4.100	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00491EB	Lead	1.700	MG/KG	
FI	CACO1	AQUATIC	WORI01	BI00491EB	Mercury	0.400	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Selenium	4.000	MG/KG	UI
FI	CACO1	AQUATIC	WORI01	BI00491EB	Silver	3.000	MG/KG	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Zinc	89.700	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Cadmium	1.900	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Chromium	4.300	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Copper	14.500	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Lead	0.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Mercury	0.400	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Selenium	18.800	MG/KG	UI
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Silver	1.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Zinc	315.000	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Cadmium	3.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Chromium	5.800	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Copper	36.800	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Lead	3.000	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Mercury	0.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Selenium	38.800	MG/KG	UI
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Silver	3.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Zinc	500.000	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Cadmium	4.100	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Chromium	7.400	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Copper	40.900	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Lead	4.300	MG/KG	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Mercury	0.900	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Selenium	40.800	MG/KG	UI
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Silver	4.100	MG/KG	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Zinc	648.000	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Cadmium	1.300	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00204EB	Chromium	2.400	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Copper	1.700	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Lead	0.900	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Mercury	0.300	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Selenium	2.700	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00204EB	Silver	1.300	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00204EB	Zinc	96.100	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00205EB	Cadmium	3.100	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Chromium	4.600	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Copper	52.600	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00205EB	Lead	2.600	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00205EB	Mercury	0.600	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Selenium	6.100	MG/KG	UI
FI	LECY1	AQUATIC	SWC001	BI00205EB	Silver	3.100	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Zinc	104.000	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00206EB	Cadmium	2.400	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Chromium	3.600	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Copper	9.900	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00206EB	Lead	1.700	MG/KG	
FI	LECY1	AQUATIC	SWC001	BI00206EB	Mercury	0.600	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Selenium	4.800	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Silver	2.400	MG/KG	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Zinc	73.200	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00275EB	Cadmium	89.800	%	
FI	MISA1	AQUATIC	SW005	BI00275EB	Cadmium	2.400	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00275EB	Chromium	94.600	%	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Chromium	2.900	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Copper	95.400	%	
FI	MISA1	AQUATIC	SW005	BI00275EB	Copper	10.300	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00275EB	Lead	1.900	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00275EB	Lead	90.600	%	
FI	MISA1	AQUATIC	SW005	BI00275EB	Mercury	0.400	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Mercury	90.800	%	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Selenium	3.900	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Selenium	54.700	%	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Silver	91.400	%	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Silver	1.900	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Zinc	98.900	%	
FI	MISA1	AQUATIC	SW005	BI00275EB	Zinc	78.100	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00276EB	Cadmium	1.600	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Chromium	2.500	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Copper	3.600	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00276EB	Lead	0.800	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00276EB	Mercury	0.500	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	MISA1	AQUATIC	SW005	BI00276EB	Selenium	3.300	MG/KG	UI
FI	MISA1	AQUATIC	SW005	BI00276EB	Silver	1.600	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Zinc	79.900	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00277EB	Cadmium	2.500	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00277EB	Chromium	3.800	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00277EB	Copper	6.800	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00277EB	Lead	1.700	MG/KG	
FI	MISA1	AQUATIC	SW005	BI00277EB	Mercury	0.500	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Selenium	4.100	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Silver	2.100	MG/KG	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Zinc	113.000	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Cadmium	1.300	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Cadmium	1.300	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Chromium	4.500	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Chromium	4.000	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Copper	9.400	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Copper	9.800	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Lead	1.200	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Lead	0.900	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Mercury	0.400	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Mercury	0.400	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Selenium	3.200	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Selenium	3.200	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Silver	2.400	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Silver	2.400	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Zinc	60.100	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Zinc	63.600	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Cadmium	1.300	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Cadmium	97.000	%	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Chromium	3.700	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Chromium	95.300	%	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Copper	8.100	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Copper	97.000	%	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Lead	0.700	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Lead	95.900	%	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Mercury	114.000	%	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Mercury	0.300	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Selenium	3.000	MG/KG	UI
FI	MISA1	AQUATIC	SWC001	BI00219EB	Selenium	130.000	%	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Silver	2.200	MG/KG	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Silver	87.800	%	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Zinc	73.800	MG/KG	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Zinc	89.300	%	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Cadmium	5.000	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Chromium	8.900	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Copper	73.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Lead	4.300	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Mercury	1.300	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Selenium	10.100	MG/KG	UI
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Silver	5.000	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Zinc	426.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Cadmium	3.200	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Chromium	10.400	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Copper	103.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Lead	3.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Mercury	0.800	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Selenium	6.300	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Silver	3.200	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Zinc	158.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Cadmium	3.300	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Chromium	10.200	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Copper	18.900	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Lead	2.300	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Mercury	0.800	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Selenium	8.200	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Silver	6.100	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Zinc	103.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Cadmium	3.900	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Chromium	11.700	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Copper	18.000	MG/KG	
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Lead	2.300	MG/KG	UI
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Mercury	1.100	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Selenium	9.300	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Silver	7.000	MG/KG	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Zinc	187.000	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Cadmium	1.700	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Cadmium	1.700	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Chromium	2.600	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Chromium	3.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Copper	83.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Copper	76.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Lead	2.800	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Lead	0.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Mercury	0.400	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Mercury	0.400	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Selenium	3.500	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Selenium	3.500	MG/KG	UI
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Silver	1.700	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Silver	1.700	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Zinc	155.000	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Zinc	158.000	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Cadmium	84.500	%	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Cadmium	1.900	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Chromium	90.900	%	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Chromium	2.800	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Copper	80.900	%	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Copper	34.200	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Lead	107.000	%	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Lead	0.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Mercury	84.000	%	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Mercury	0.400	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Selenium	3.700	MG/KG	UI
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Selenium	63.500	%	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Silver	86.300	%	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Silver	1.900	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Zinc	205.000	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Zinc	94.000	%	
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Cadmium	1.600	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Chromium	2.500	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Copper	17.700	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Lead	0.900	MG/KG	
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Mercury	0.300	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Selenium	3.200	MG/KG	UI
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Silver	1.600	MG/KG	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Zinc	223.000	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Cadmium	1.300	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Cadmium	1.100	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Chromium	5.700	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Chromium	5.700	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Copper	12.300	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Copper	10.400	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Lead	2.400	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Lead	4.700	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Mercury	0.500	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Mercury	0.500	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Selenium	4.600	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Selenium	4.900	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Silver	3.400	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Silver	3.400	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Zinc	399.000	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Zinc	281.000	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Cadmium	95.200	%	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Cadmium	1.300	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Chromium	6.500	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Chromium	95.200	%	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Copper	54.600	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Copper	98.400	%	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Lead	3.100	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Lead	97.200	%	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Mercury	0.600	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Mercury	79.000	%	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Selenium	53.900	%	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Selenium	5.200	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Silver	3.900	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Silver	84.600	%	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Zinc	433.000	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Zinc	86.100	%	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Cadmium	1.400	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Chromium	7.100	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Copper	8.400	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Lead	3.200	MG/KG	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Mercury	0.600	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Selenium	5.700	MG/KG	UI
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Silver	4.300	MG/KG	U
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Zinc	538.000	MG/KG	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Cadmium	0.500	MG/KG	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Chromium	3.000	MG/KG	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Copper	21.700	MG/KG	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Lead	2.100	MG/KG	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Mercury	0.200	MG/KG	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Selenium	2.400	MG/KG	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Silver	1.800	MG/KG	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Zinc	141.000	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00477EB	Cadmium	2.400	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Chromium	12.100	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Copper	11.900	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00477EB	Lead	5.800	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00477EB	Mercury	0.900	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Selenium	9.700	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Silver	7.300	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Zinc	193.000	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00478EB	Cadmium	2.500	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Chromium	12.700	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Copper	14.500	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00478EB	Lead	3.600	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00478EB	Mercury	1.300	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Selenium	10.100	MG/KG	UI
FI	SEAT1	AQUATIC	SW026	BI00478EB	Silver	7.600	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Zinc	129.000	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00479EB	Cadmium	2.500	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Chromium	12.600	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Copper	10.100	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Lead	3.900	MG/KG	
FI	SEAT1	AQUATIC	SW026	BI00479EB	Mercury	1.000	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Selenium	10.100	MG/KG	UI
FI	SEAT1	AQUATIC	SW026	BI00479EB	Silver	7.500	MG/KG	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Zinc	272.000	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00484EB	Cadmium	2.600	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Chromium	13.200	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Copper	10.500	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Lead	5.700	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00484EB	Mercury	1.300	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Selenium	10.500	MG/KG	UI
FI	SEAT1	AQUATIC	SW033	BI00484EB	Silver	7.900	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Zinc	302.000	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00485EB	Cadmium	2.600	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Chromium	13.200	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Copper	19.400	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00485EB	Lead	3.400	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00485EB	Mercury	1.300	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Selenium	10.500	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Silver	7.900	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Zinc	296.000	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00486EB	Cadmium	2.300	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	SEAT1	AQUATIC	SW033	BI00486EB	Chromium	11.500	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Copper	13.500	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00486EB	Lead	4.000	MG/KG	
FI	SEAT1	AQUATIC	SW033	BI00486EB	Mercury	1.000	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Selenium	9.200	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Silver	6.900	MG/KG	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Zinc	265.000	MG/KG	
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Cadmium	8.300	MG/KG	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Chromium	12.500	MG/KG	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Copper	657.000	MG/KG	
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Lead	6.400	MG/KG	
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Mercury	1.700	MG/KG	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Silver	8.300	MG/KG	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Zinc	539.000	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Cadmium	1.900	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Chromium	9.600	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Copper	7.700	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Lead	3.500	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Mercury	0.900	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Selenium	7.700	MG/KG	UI
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Silver	5.800	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Zinc	185.000	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Cadmium	2.100	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Chromium	10.600	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Copper	8.500	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Lead	2.400	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Mercury	0.900	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Selenium	8.500	MG/KG	UI
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Silver	6.400	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Zinc	145.000	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Cadmium	1.800	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Chromium	8.800	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Copper	7.100	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Lead	3.800	MG/KG	
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Mercury	0.800	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Selenium	7.100	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Silver	5.300	MG/KG	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Zinc	192.000	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Cadmium	2.000	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Chromium	3.000	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Copper	58.400	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Lead	1.000	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Mercury	0.500	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Selenium	4.000	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Silver	2.000	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Zinc	55.900	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Cadmium	1.700	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Chromium	2.600	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Copper	65.700	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Lead	0.900	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Mercury	0.400	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Selenium	3.500	MG/KG	UI
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Silver	1.700	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Zinc	106.000	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Cadmium	1.900	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Chromium	2.900	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Copper	13.800	MG/KG	
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Lead	0.900	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Mercury	0.300	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Selenium	3.800	MG/KG	UI
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Silver	1.900	MG/KG	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Zinc	56.900	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Cadmium	1.300	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Chromium	6.600	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Copper	16.000	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Lead	2.000	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Mercury	0.500	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Selenium	5.300	MG/KG	UI

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Silver	4.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Zinc	53.400	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Cadmium	1.500	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Chromium	7.500	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Copper	6.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Lead	2.800	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Mercury	0.600	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Selenium	6.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Silver	4.500	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Zinc	33.800	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Cadmium	1.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Chromium	5.200	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Copper	4.100	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Lead	1.600	MG/KG	I
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Mercury	0.400	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Selenium	4.100	MG/KG	UI
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Silver	3.100	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Zinc	25.200	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Cadmium	3.300	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Chromium	10.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Copper	57.200	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Lead	5.700	MG/KG	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Mercury	0.900	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Selenium	8.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Silver	6.000	MG/KG	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Zinc	233.000	MG/KG	
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Cadmium	1.500	MG/KG	U
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Chromium	7.500	MG/KG	U
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Copper	48.900	MG/KG	
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Lead	2.600	MG/KG	
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Mercury	0.700	MG/KG	U
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Selenium	9.200	MG/KG	
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Silver	4.500	MG/KG	U
HE	AMTI1	AQUATIC	WOSP01	BI00502EB	Zinc	58.200	MG/KG	
HE	THRA1	AQUATIC	SW003	BI00185EB	Cadmium	94.500	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Cadmium	0.800	MG/KG	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Chromium	4.400	MG/KG	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Chromium	89.700	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Copper	3.500	MG/KG	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Copper	95.500	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Lead	261.000	%	
HE	THRA1	AQUATIC	SW003	BI00185EB	Lead	1.300	MG/KG	
HE	THRA1	AQUATIC	SW003	BI00185EB	Mercury	74.000	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Mercury	0.400	MG/KG	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Selenium	135.000	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Selenium	3.500	MG/KG	UI
HE	THRA1	AQUATIC	SW003	BI00185EB	Silver	2.600	MG/KG	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Silver	85.700	%	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Zinc	19.500	MG/KG	
HE	THRA1	AQUATIC	SW003	BI00185EB	Zinc	94.000	%	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Cadmium	2.500	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Cadmium	2.300	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Chromium	4.200	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Chromium	4.200	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Copper	17.400	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Copper	15.700	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Lead	2.500	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Lead	2.400	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Mercury	0.400	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Mercury	0.400	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Selenium	9.300	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Selenium	11.400	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Silver	2.500	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Silver	2.500	MG/KG	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Zinc	85.800	MG/KG	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Zinc	129.000	MG/KG	
HE	THRA1	XERIC	MX01R	BI00299EB	Cadmium	0.600	MG/KG	U
HE	THRA1	XERIC	MX01R	BI00299EB	Chromium	3.100	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
HE	THRA1	XERIC	MX01R	BI00299EB	Copper	6.400	MG/KG	
HE	THRA1	XERIC	MX01R	BI00299EB	Lead	1.100	MG/KG	
HE	THRA1	XERIC	MX01R	BI00299EB	Mercury	0.200	MG/KG	U
HE	THRA1	XERIC	MX01R	BI00299EB	Selenium	2.500	MG/KG	UI
HE	THRA1	XERIC	MX01R	BI00299EB	Silver	1.900	MG/KG	U
HE	THRA1	XERIC	MX01R	BI00299EB	Zinc	32.500	MG/KG	
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Cadmium	2.300	MG/KG	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Chromium	3.400	MG/KG	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Copper	19.800	MG/KG	
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Lead	2.900	MG/KG	
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Mercury	0.400	MG/KG	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Selenium	4.500	MG/KG	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Silver	2.300	MG/KG	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Zinc	90.800	MG/KG	
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Cadmium	2.400	MG/KG	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Chromium	4.900	MG/KG	
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Copper	19.400	MG/KG	
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Lead	3.800	MG/KG	
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Mercury	0.600	MG/KG	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Selenium	4.800	MG/KG	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Silver	2.400	MG/KG	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Zinc	110.000	MG/KG	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Cadmium	1.900	MG/KG	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Chromium	9.700	MG/KG	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Copper	26.200	MG/KG	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Lead	1.700	MG/KG	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Mercury	0.600	MG/KG	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Selenium	5.900	MG/KG	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Silver	4.400	MG/KG	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Zinc	157.000	MG/KG	
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Cadmium	1.200	MG/KG	
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Chromium	5.800	MG/KG	U
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Copper	10.800	MG/KG	
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Lead	1.200	MG/KG	
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Mercury	0.500	MG/KG	U
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Selenium	4.700	MG/KG	UI
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Silver	3.500	MG/KG	U
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Zinc	106.000	MG/KG	
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Cadmium	2.300	MG/KG	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Chromium	4.600	MG/KG	
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Copper	18.300	MG/KG	
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Lead	2.000	MG/KG	
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Mercury	0.500	MG/KG	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Selenium	4.600	MG/KG	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Silver	2.300	MG/KG	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Zinc	127.000	MG/KG	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Cadmium	3.100	MG/KG	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Chromium	6.800	MG/KG	U
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Copper	18.800	MG/KG	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Lead	1.700	MG/KG	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Mercury	0.600	MG/KG	U
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Selenium	5.400	MG/KG	U
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Silver	4.100	MG/KG	U
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Zinc	108.000	MG/KG	
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Cadmium	2.300	MG/KG	
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Chromium	6.900	MG/KG	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Copper	21.300	MG/KG	
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Lead	1.800	MG/KG	
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Mercury	0.600	MG/KG	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Selenium	5.500	MG/KG	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Silver	4.100	MG/KG	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Zinc	104.000	MG/KG	
SM	MIPE1	MESIC	MD02A	BI00187EB	Cadmium	2.100	MG/KG	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Chromium	3.100	MG/KG	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Copper	36.200	MG/KG	
SM	MIPE1	MESIC	MD02A	BI00187EB	Lead	2.300	MG/KG	
SM	MIPE1	MESIC	MD02A	BI00187EB	Mercury	0.500	MG/KG	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Selenium	4.200	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	MIPE1	MESIC	MD02A	BI00187EB	Silver	2.100	MG/KG	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Zinc	113.000	MG/KG	
SM	MIPE1	MESIC	MG01A	BI00366EB	Cadmium	6.400	MG/KG	
SM	MIPE1	MESIC	MG01A	BI00366EB	Chromium	6.500	MG/KG	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Copper	34.400	MG/KG	
SM	MIPE1	MESIC	MG01A	BI00366EB	Lead	6.900	MG/KG	
SM	MIPE1	MESIC	MG01A	BI00366EB	Mercury	0.900	MG/KG	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Selenium	8.700	MG/KG	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Silver	4.300	MG/KG	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Zinc	157.000	MG/KG	
SM	MIPE1	MESIC	MG04A	BI00353EB	Cadmium	3.000	MG/KG	
SM	MIPE1	MESIC	MG04A	BI00353EB	Chromium	3.300	MG/KG	U
SM	MIPE1	MESIC	MG04A	BI00353EB	Copper	13.000	MG/KG	
SM	MIPE1	MESIC	MG04A	BI00353EB	Lead	1.900	MG/KG	
SM	MIPE1	MESIC	MG04A	BI00353EB	Mercury	0.500	MG/KG	U
SM	MIPE1	MESIC	MG04A	BI00353EB	Selenium	4.400	MG/KG	U
SM	MIPE1	MESIC	MG04A	BI00353EB	Silver	2.200	MG/KG	U
SM	MIPE1	MESIC	MG04A	BI00353EB	Zinc	92.300	MG/KG	
SM	MIPE1	MESIC	MR02A	BI00364EB	Cadmium	4.100	MG/KG	
SM	MIPE1	MESIC	MR02A	BI00364EB	Chromium	5.100	MG/KG	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Copper	18.200	MG/KG	
SM	MIPE1	MESIC	MR02A	BI00364EB	Lead	3.100	MG/KG	
SM	MIPE1	MESIC	MR02A	BI00364EB	Mercury	0.800	MG/KG	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Selenium	6.800	MG/KG	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Silver	3.400	MG/KG	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Zinc	139.000	MG/KG	
SM	MIPE1	MESIC	MR04A	BI00354EB	Cadmium	2.600	MG/KG	
SM	MIPE1	MESIC	MR04A	BI00354EB	Chromium	3.600	MG/KG	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Copper	18.600	MG/KG	
SM	MIPE1	MESIC	MR04A	BI00354EB	Lead	1.500	MG/KG	
SM	MIPE1	MESIC	MR04A	BI00354EB	Mercury	0.600	MG/KG	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Selenium	4.800	MG/KG	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Silver	2.400	MG/KG	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Zinc	91.200	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Cadmium	2.500	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Cadmium	2.500	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Chromium	3.800	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Chromium	3.800	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Copper	23.800	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Copper	18.700	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Lead	1.800	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Lead	2.300	MG/KG	I
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Mercury	0.500	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Mercury	0.600	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Selenium	6.000	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Selenium	6.900	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Silver	2.500	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Silver	2.500	MG/KG	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Zinc	98.300	MG/KG	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Zinc	91.100	MG/KG	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Cadmium	1.600	MG/KG	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Chromium	5.000	MG/KG	U
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Copper	17.000	MG/KG	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Lead	1.500	MG/KG	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Mercury	0.500	MG/KG	U
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Selenium	4.000	MG/KG	U
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Silver	3.000	MG/KG	U
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Zinc	96.900	MG/KG	
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Cadmium	1.900	MG/KG	
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Chromium	5.700	MG/KG	U
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Copper	22.000	MG/KG	
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Lead	1.100	MG/KG	U
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Mercury	0.400	MG/KG	U
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Selenium	4.600	MG/KG	UI
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Silver	3.400	MG/KG	U
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Zinc	133.000	MG/KG	
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Cadmium	2.600	MG/KG	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Chromium	3.900	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Copper	15.700	MG/KG	
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Lead	2.100	MG/KG	
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Mercury	0.600	MG/KG	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Selenium	5.200	MG/KG	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Silver	2.600	MG/KG	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Zinc	210.000	MG/KG	
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Cadmium	1.400	MG/KG	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Chromium	6.800	MG/KG	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Copper	16.800	MG/KG	
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Lead	2.600	MG/KG	
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Mercury	0.500	MG/KG	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Selenium	5.400	MG/KG	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Silver	4.100	MG/KG	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Zinc	106.000	MG/KG	
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Cadmium	1.300	MG/KG	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Chromium	6.300	MG/KG	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Copper	16.600	MG/KG	
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Lead	1.600	MG/KG	
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Mercury	0.500	MG/KG	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Selenium	5.100	MG/KG	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Silver	3.800	MG/KG	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Zinc	101.000	MG/KG	
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Cadmium	2.300	MG/KG	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Chromium	3.400	MG/KG	
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Copper	17.300	MG/KG	
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Lead	1.200	MG/KG	
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Mercury	0.400	MG/KG	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Selenium	4.500	MG/KG	UI
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Silver	2.300	MG/KG	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Zinc	57.800	MG/KG	
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Cadmium	0.900	MG/KG	
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Chromium	4.700	MG/KG	U
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Copper	11.500	MG/KG	
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Lead	0.900	MG/KG	U
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Mercury	0.300	MG/KG	U
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Selenium	3.700	MG/KG	UI
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Silver	2.800	MG/KG	U
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Zinc	74.500	MG/KG	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Cadmium	95.700	%	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Cadmium	2.200	MG/KG	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Chromium	94.500	%	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Chromium	3.300	MG/KG	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Copper	93.600	%	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Copper	28.200	MG/KG	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Lead	2.900	MG/KG	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Lead	92.100	%	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Mercury	85.800	%	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Mercury	0.500	MG/KG	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Selenium	4.400	MG/KG	UI
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Selenium	135.000	%	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Silver	88.000	%	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Silver	2.200	MG/KG	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Zinc	89.500	%	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Zinc	153.000	MG/KG	
SM	PEMA1	MESIC	MD01A	BI00190EB	Cadmium	3.100	MG/KG	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Chromium	4.600	MG/KG	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Copper	158.000	MG/KG	
SM	PEMA1	MESIC	MD01A	BI00190EB	Lead	2.600	MG/KG	
SM	PEMA1	MESIC	MD01A	BI00190EB	Mercury	0.600	MG/KG	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Selenium	6.200	MG/KG	UI
SM	PEMA1	MESIC	MD01A	BI00190EB	Silver	3.100	MG/KG	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Zinc	93.800	MG/KG	
SM	PEMA1	MESIC	MD01B	BI00269EB	Cadmium	3.100	MG/KG	
SM	PEMA1	MESIC	MD01B	BI00269EB	Chromium	6.900	MG/KG	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Copper	26.600	MG/KG	
SM	PEMA1	MESIC	MD01B	BI00269EB	Lead	1.400	MG/KG	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Mercury	0.600	MG/KG	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Selenium	5.500	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	PEMA1	MESIC	MD01B	BI00269EB	Silver	4.100	MG/KG	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Zinc	128.000	MG/KG	
SM	PEMA1	MESIC	MG01R	BI00267EB	Cadmium	2.400	MG/KG	
SM	PEMA1	MESIC	MG01R	BI00267EB	Chromium	7.300	MG/KG	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Copper	42.800	MG/KG	
SM	PEMA1	MESIC	MG01R	BI00267EB	Lead	1.700	MG/KG	
SM	PEMA1	MESIC	MG01R	BI00267EB	Mercury	0.700	MG/KG	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Selenium	5.900	MG/KG	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Silver	4.400	MG/KG	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Zinc	112.000	MG/KG	
SM	PEMA1	MESIC	MG02R	BI00266EB	Cadmium	3.000	MG/KG	
SM	PEMA1	MESIC	MG02R	BI00266EB	Chromium	9.100	MG/KG	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Copper	19.600	MG/KG	
SM	PEMA1	MESIC	MG02R	BI00266EB	Lead	1.800	MG/KG	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Mercury	0.800	MG/KG	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Selenium	7.300	MG/KG	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Silver	5.400	MG/KG	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Zinc	144.000	MG/KG	
SM	PEMA1	MESIC	MG03A	BI00365EB	Cadmium	10.600	MG/KG	
SM	PEMA1	MESIC	MG03A	BI00365EB	Chromium	13.000	MG/KG	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Copper	43.100	MG/KG	
SM	PEMA1	MESIC	MG03A	BI00365EB	Lead	8.500	MG/KG	
SM	PEMA1	MESIC	MG03A	BI00365EB	Mercury	1.800	MG/KG	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Selenium	17.400	MG/KG	UI
SM	PEMA1	MESIC	MG03A	BI00365EB	Silver	8.700	MG/KG	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Zinc	151.000	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Cadmium	3.900	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Cadmium	2.700	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Chromium	4.900	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Chromium	4.000	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Copper	21.600	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Copper	16.200	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Lead	2.500	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Lead	2.700	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Mercury	0.600	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Mercury	0.600	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Selenium	5.200	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Selenium	5.300	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Silver	2.700	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Silver	2.600	MG/KG	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Zinc	124.000	MG/KG	
SM	PEMA1	MESIC	MG04R	BI00271EB	Zinc	146.000	MG/KG	
SM	PEMA1	XERIC	MX01R	BI00268EB	Cadmium	1.900	MG/KG	
SM	PEMA1	XERIC	MX01R	BI00268EB	Chromium	7.000	MG/KG	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Copper	19.500	MG/KG	
SM	PEMA1	XERIC	MX01R	BI00268EB	Lead	1.500	MG/KG	
SM	PEMA1	XERIC	MX01R	BI00268EB	Mercury	0.600	MG/KG	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Selenium	5.600	MG/KG	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Silver	4.200	MG/KG	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Zinc	113.000	MG/KG	
SM	PEMA1	XERIC	MX02R	BI00263EB	Cadmium	1.000	MG/KG	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Chromium	5.100	MG/KG	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Copper	16.600	MG/KG	
SM	PEMA1	XERIC	MX02R	BI00263EB	Lead	1.200	MG/KG	
SM	PEMA1	XERIC	MX02R	BI00263EB	Mercury	0.400	MG/KG	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Selenium	4.100	MG/KG	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Silver	3.100	MG/KG	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Zinc	109.000	MG/KG	
SM	PEMA1	XERIC	MX03R	BI00265EB	Cadmium	3.300	MG/KG	
SM	PEMA1	XERIC	MX03R	BI00265EB	Chromium	7.300	MG/KG	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Copper	22.500	MG/KG	
SM	PEMA1	XERIC	MX03R	BI00265EB	Lead	1.700	MG/KG	
SM	PEMA1	XERIC	MX03R	BI00265EB	Mercury	0.700	MG/KG	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Selenium	5.800	MG/KG	UI
SM	PEMA1	XERIC	MX03R	BI00265EB	Silver	4.400	MG/KG	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Zinc	117.000	MG/KG	
TA	ACRI	HYDRIC	MA01R	BI00328EB	Cadmium	3.800	MG/KG	
TA	ACRI	HYDRIC	MA01R	BI00328EB	Chromium	5.400	MG/KG	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
TA	ACRI	HYDRIC	MA01R	BI00328EB	Copper	51.800	MG/KG	
TA	ACRI	HYDRIC	MA01R	BI00328EB	Lead	2.900	MG/KG	
TA	ACRI	HYDRIC	MA01R	BI00328EB	Mercury	0.800	MG/KG	U
TA	ACRI	HYDRIC	MA01R	BI00328EB	Selenium	7.100	MG/KG	U
TA	ACRI	HYDRIC	MA01R	BI00328EB	Silver	3.600	MG/KG	U
TA	ACRI	HYDRIC	MA01R	BI00328EB	Zinc	144.000	MG/KG	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Cadmium	6.400	MG/KG	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Chromium	6.500	MG/KG	U
TA	ACRI	HYDRIC	MA04A	BI00241EB	Copper	204.000	MG/KG	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Lead	3.600	MG/KG	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Mercury	1.000	MG/KG	U
TA	ACRI	HYDRIC	MA04A	BI00241EB	Selenium	8.600	MG/KG	UI
TA	ACRI	HYDRIC	MA04A	BI00241EB	Silver	4.300	MG/KG	U
TA	ACRI	HYDRIC	MA04A	BI00241EB	Zinc	210.000	MG/KG	
TA	ACRI	HYDRIC	MW01A	BI00300EB	Cadmium	0.700	MG/KG	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Chromium	3.500	MG/KG	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Copper	32.100	MG/KG	
TA	ACRI	HYDRIC	MW01A	BI00300EB	Lead	0.900	MG/KG	
TA	ACRI	HYDRIC	MW01A	BI00300EB	Mercury	0.300	MG/KG	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Selenium	2.800	MG/KG	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Silver	2.100	MG/KG	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Zinc	47.000	MG/KG	
TA	ACRI	HYDRIC	MW03R	BI00327EB	Cadmium	3.600	MG/KG	
TA	ACRI	HYDRIC	MW03R	BI00327EB	Chromium	5.000	MG/KG	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Copper	66.300	MG/KG	
TA	ACRI	HYDRIC	MW03R	BI00327EB	Lead	3.200	MG/KG	
TA	ACRI	HYDRIC	MW03R	BI00327EB	Mercury	0.700	MG/KG	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Selenium	6.600	MG/KG	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Silver	3.300	MG/KG	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Zinc	129.000	MG/KG	
TA	ACRI	MESIC	MD01A	BI00262EB	Cadmium	3.800	MG/KG	
TA	ACRI	MESIC	MD01A	BI00262EB	Chromium	4.700	MG/KG	U
TA	ACRI	MESIC	MD01A	BI00262EB	Copper	133.000	MG/KG	
TA	ACRI	MESIC	MD01A	BI00262EB	Lead	1.600	MG/KG	U
TA	ACRI	MESIC	MD01A	BI00262EB	Mercury	0.800	MG/KG	U
TA	ACRI	MESIC	MD01A	BI00262EB	Selenium	6.300	MG/KG	U
TA	ACRI	MESIC	MD01A	BI00262EB	Silver	3.100	MG/KG	U
TA	ACRI	MESIC	MD01A	BI00262EB	Zinc	144.000	MG/KG	
TA	ACRI	MESIC	MG03A	BI00249EB	Cadmium	4.600	MG/KG	
TA	ACRI	MESIC	MG03A	BI00249EB	Chromium	6.500	MG/KG	U
TA	ACRI	MESIC	MG03A	BI00249EB	Copper	130.000	MG/KG	
TA	ACRI	MESIC	MG03A	BI00249EB	Lead	3.500	MG/KG	I
TA	ACRI	MESIC	MG03A	BI00249EB	Mercury	1.100	MG/KG	U
TA	ACRI	MESIC	MG03A	BI00249EB	Selenium	8.600	MG/KG	UI
TA	ACRI	MESIC	MG03A	BI00249EB	Silver	4.300	MG/KG	U
TA	ACRI	MESIC	MG03A	BI00249EB	Zinc	242.000	MG/KG	
TA	ACRI	MESIC	MG03R	BI00301EB	Cadmium	3.600	MG/KG	
TA	ACRI	MESIC	MG03R	BI00301EB	Chromium	4.000	MG/KG	U
TA	ACRI	MESIC	MG03R	BI00301EB	Copper	73.900	MG/KG	
TA	ACRI	MESIC	MG03R	BI00301EB	Lead	1.300	MG/KG	U
TA	ACRI	MESIC	MG03R	BI00301EB	Mercury	0.600	MG/KG	U
TA	ACRI	MESIC	MG03R	BI00301EB	Selenium	5.400	MG/KG	U
TA	ACRI	MESIC	MG03R	BI00301EB	Silver	2.700	MG/KG	U
TA	ACRI	MESIC	MG03R	BI00301EB	Zinc	138.000	MG/KG	
TA	ACRI	MESIC	MR03A	BI00302EB	Cadmium	3.600	MG/KG	U
TA	ACRI	MESIC	MR03A	BI00302EB	Chromium	5.400	MG/KG	U
TA	ACRI	MESIC	MR03A	BI00302EB	Copper	89.200	MG/KG	
TA	ACRI	MESIC	MR03A	BI00302EB	Lead	1.900	MG/KG	
TA	ACRI	MESIC	MR03A	BI00302EB	Mercury	0.800	MG/KG	U
TA	ACRI	MESIC	MR03A	BI00302EB	Selenium	7.300	MG/KG	U
TA	ACRI	MESIC	MR03A	BI00302EB	Silver	3.600	MG/KG	U
TA	ACRI	MESIC	MR03A	BI00302EB	Zinc	162.000	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Cadmium	1.900	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Cadmium	1.600	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Chromium	3.000	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Chromium	2.500	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Copper	11.200	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Copper	11.500	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Lead	0.800	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Lead	0.700	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Mercury	0.100	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Mercury	0.100	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Selenium	4.300	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Selenium	0.800	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Silver	0.600	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Silver	0.600	MG/KG	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Zinc	53.000	MG/KG	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Zinc	53.300	MG/KG	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Cadmium	1.100	MG/KG	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Chromium	5.400	MG/KG	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Copper	10.200	MG/KG	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Lead	0.900	MG/KG	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Mercury	0.100	MG/KG	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Selenium	0.900	MG/KG	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Silver	0.400	MG/KG	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Zinc	55.900	MG/KG	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Cadmium	1.100	MG/KG	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Chromium	23.300	MG/KG	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Copper	7.500	MG/KG	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Lead	0.900	MG/KG	I
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Mercury	0.100	MG/KG	U
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Selenium	0.800	MG/KG	UI
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Silver	0.600	MG/KG	U
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Zinc	53.900	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00318EB	Cadmium	0.400	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00318EB	Chromium	1.200	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00318EB	Copper	9.500	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00318EB	Lead	1.000	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00318EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00318EB	Selenium	0.800	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00318EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00318EB	Zinc	45.600	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00520EB	Cadmium	0.600	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00520EB	Chromium	1.000	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00520EB	Copper	11.400	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00520EB	Lead	0.900	MG/KG	
VE	ARLU1	MESIC	MG02A	BI00520EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00520EB	Selenium	0.800	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00520EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG02A	BI00520EB	Zinc	50.900	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00517EB	Cadmium	1.800	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00517EB	Chromium	2.100	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00517EB	Copper	15.200	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00517EB	Lead	1.100	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00517EB	Mercury	0.000	MG/KG	U
VE	ARLU1	MESIC	MG03A	BI00517EB	Selenium	0.800	MG/KG	U
VE	ARLU1	MESIC	MG03A	BI00517EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG03A	BI00517EB	Zinc	48.100	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00518EB	Cadmium	1.900	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00518EB	Chromium	1.200	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00518EB	Copper	14.600	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00518EB	Lead	1.000	MG/KG	
VE	ARLU1	MESIC	MG03A	BI00518EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG03A	BI00518EB	Selenium	0.800	MG/KG	UI
VE	ARLU1	MESIC	MG03A	BI00518EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG03A	BI00518EB	Zinc	56.400	MG/KG	
VE	ARLU1	MESIC	MG03R	BI00336EB	Cadmium	84.300	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Cadmium	0.600	MG/KG	
VE	ARLU1	MESIC	MG03R	BI00336EB	Chromium	85.900	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Chromium	1.300	MG/KG	
VE	ARLU1	MESIC	MG03R	BI00336EB	Copper	89.900	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Copper	10.400	MG/KG	
VE	ARLU1	MESIC	MG03R	BI00336EB	Lead	1.400	MG/KG	I
VE	ARLU1	MESIC	MG03R	BI00336EB	Lead	73.300	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG03R	BI00336EB	Mercury	63.000	%	U

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	ARLU1	MESIC	MG03R	BI00336EB	Selenium	1.000	MG/KG	U
VE	ARLU1	MESIC	MG03R	BI00336EB	Selenium	0.700	%	U
VE	ARLU1	MESIC	MG03R	BI00336EB	Silver	78.000	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Silver	0.700	MG/KG	
VE	ARLU1	MESIC	MG03R	BI00336EB	Zinc	81.400	%	
VE	ARLU1	MESIC	MG03R	BI00336EB	Zinc	38.300	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00256EB	Cadmium	0.600	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00256EB	Chromium	1.100	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00256EB	Copper	10.400	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00256EB	Lead	0.900	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00256EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG04A	BI00256EB	Selenium	0.900	MG/KG	U
VE	ARLU1	MESIC	MG04A	BI00256EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG04A	BI00256EB	Zinc	46.900	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00523EB	Cadmium	0.800	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00523EB	Chromium	3.400	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00523EB	Copper	16.300	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00523EB	Lead	1.900	MG/KG	
VE	ARLU1	MESIC	MG04A	BI00523EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MG04A	BI00523EB	Selenium	0.800	MG/KG	UI
VE	ARLU1	MESIC	MG04A	BI00523EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG04A	BI00523EB	Zinc	59.800	MG/KG	
VE	ARLU1	MESIC	MG04R	BI00280EB	Cadmium	1.200	MG/KG	
VE	ARLU1	MESIC	MG04R	BI00280EB	Chromium	1.100	MG/KG	
VE	ARLU1	MESIC	MG04R	BI00280EB	Copper	10.700	MG/KG	
VE	ARLU1	MESIC	MG04R	BI00280EB	Lead	1.100	MG/KG	I
VE	ARLU1	MESIC	MG04R	BI00280EB	Mercury	0.000	MG/KG	U
VE	ARLU1	MESIC	MG04R	BI00280EB	Selenium	0.800	MG/KG	UI
VE	ARLU1	MESIC	MG04R	BI00280EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MG04R	BI00280EB	Zinc	44.800	MG/KG	
VE	ARLU1	MESIC	MR02A	BI00320EB	Cadmium	0.500	MG/KG	
VE	ARLU1	MESIC	MR02A	BI00320EB	Chromium	2.700	MG/KG	
VE	ARLU1	MESIC	MR02A	BI00320EB	Copper	12.600	MG/KG	
VE	ARLU1	MESIC	MR02A	BI00320EB	Lead	1.000	MG/KG	
VE	ARLU1	MESIC	MR02A	BI00320EB	Mercury	0.000	MG/KG	U
VE	ARLU1	MESIC	MR02A	BI00320EB	Selenium	0.800	MG/KG	UI
VE	ARLU1	MESIC	MR02A	BI00320EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MR02A	BI00320EB	Zinc	23.100	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Cadmium	0.900	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Cadmium	0.800	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Chromium	1.600	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Chromium	1.200	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Copper	9.700	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Copper	10.400	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Lead	0.700	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Lead	0.600	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MR03A	BI00282EB	Selenium	1.500	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Selenium	0.900	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MR03A	BI00282EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MR03A	BI00282EB	Zinc	43.300	MG/KG	
VE	ARLU1	MESIC	MR03A	BI00282EB	Zinc	40.900	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00259EB	Cadmium	0.400	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00259EB	Chromium	1.900	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00259EB	Copper	10.000	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00259EB	Lead	0.900	MG/KG	I
VE	ARLU1	MESIC	MR04A	BI00259EB	Mercury	0.000	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00259EB	Selenium	0.800	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00259EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00259EB	Zinc	29.100	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00516EB	Cadmium	0.500	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00516EB	Chromium	1.600	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00516EB	Copper	8.100	MG/KG	
VE	ARLU1	MESIC	MR04A	BI00516EB	Lead	0.700	MG/KG	I
VE	ARLU1	MESIC	MR04A	BI00516EB	Mercury	0.100	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00516EB	Mercury	77.000	%	U
VE	ARLU1	MESIC	MR04A	BI00516EB	Selenium	2.300	MG/KG	I

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	ARLU1	MESIC	MR04A	BI00516EB	Silver	0.400	MG/KG	U
VE	ARLU1	MESIC	MR04A	BI00516EB	Zinc	30.000	MG/KG	
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Cadmium	0.400	MG/KG	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Chromium	0.600	MG/KG	
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Copper	11.100	MG/KG	
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Lead	0.500	MG/KG	I
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Mercury	0.000	MG/KG	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Selenium	0.800	MG/KG	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Silver	0.400	MG/KG	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Zinc	60.500	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00319EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00319EB	Chromium	1.400	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00319EB	Copper	4.000	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00319EB	Lead	0.800	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00319EB	Mercury	0.100	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00319EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00319EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00319EB	Zinc	14.400	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00521EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00521EB	Chromium	1.700	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00521EB	Copper	14.000	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00521EB	Lead	0.700	MG/KG	
VE	BOGR1	MESIC	MG02A	BI00521EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00521EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00521EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG02A	BI00521EB	Zinc	14.600	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00341EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00341EB	Chromium	2.200	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00341EB	Copper	2.000	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00341EB	Lead	0.700	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00341EB	Mercury	0.100	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00341EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00341EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00341EB	Zinc	12.100	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00519EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00519EB	Chromium	2.100	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00519EB	Copper	2.200	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00519EB	Lead	0.700	MG/KG	
VE	BOGR1	MESIC	MG03A	BI00519EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00519EB	Selenium	0.800	MG/KG	UI
VE	BOGR1	MESIC	MG03A	BI00519EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03A	BI00519EB	Zinc	10.800	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Chromium	1.200	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Chromium	1.300	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Copper	3.400	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Copper	2.900	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Lead	1.400	MG/KG	I
VE	BOGR1	MESIC	MG03R	BI00333EB	Lead	1.200	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Zinc	14.300	MG/KG	
VE	BOGR1	MESIC	MG03R	BI00333EB	Zinc	14.200	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00255EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00255EB	Chromium	1.600	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00255EB	Copper	1.900	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00255EB	Lead	0.600	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00255EB	Mercury	0.100	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00255EB	Selenium	0.800	MG/KG	UI
VE	BOGR1	MESIC	MG04A	BI00255EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00255EB	Zinc	20.700	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00522EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00522EB	Chromium	1.300	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	BOGR1	MESIC	MG04A	BI00522EB	Copper	5.400	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00522EB	Lead	1.300	MG/KG	
VE	BOGR1	MESIC	MG04A	BI00522EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00522EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00522EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04A	BI00522EB	Zinc	23.700	MG/KG	
VE	BOGR1	MESIC	MG04R	BI00281EB	Cadmium	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Chromium	1.200	MG/KG	
VE	BOGR1	MESIC	MG04R	BI00281EB	Copper	4.700	MG/KG	
VE	BOGR1	MESIC	MG04R	BI00281EB	Lead	0.700	MG/KG	I
VE	BOGR1	MESIC	MG04R	BI00281EB	Mercury	0.000	MG/KG	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Selenium	0.800	MG/KG	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Silver	0.400	MG/KG	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Zinc	19.800	MG/KG	
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Chromium	1.100	MG/KG	
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Copper	3.100	MG/KG	
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Lead	0.400	MG/KG	I
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Mercury	0.000	MG/KG	U
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Selenium	0.800	MG/KG	UI
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Silver	0.400	MG/KG	U
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Zinc	19.400	MG/KG	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Chromium	1.900	MG/KG	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Copper	2.800	MG/KG	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Lead	0.500	MG/KG	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Mercury	0.100	MG/KG	U
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Selenium	0.800	MG/KG	UI
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Silver	0.400	MG/KG	U
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Zinc	10.100	MG/KG	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Cadmium	0.300	MG/KG	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Chromium	34.100	MG/KG	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Copper	2.100	MG/KG	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Lead	0.800	MG/KG	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Mercury	0.000	MG/KG	U
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Selenium	0.900	MG/KG	UI
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Silver	0.600	MG/KG	U
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Zinc	28.100	MG/KG	
VE	BRIN1	MESIC	MD01A	BI00308EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	MESIC	MD01A	BI00308EB	Chromium	1.500	MG/KG	
VE	BRIN1	MESIC	MD01A	BI00308EB	Copper	4.800	MG/KG	
VE	BRIN1	MESIC	MD01A	BI00308EB	Lead	0.700	MG/KG	I
VE	BRIN1	MESIC	MD01A	BI00308EB	Mercury	0.100	MG/KG	U
VE	BRIN1	MESIC	MD01A	BI00308EB	Selenium	0.800	MG/KG	U
VE	BRIN1	MESIC	MD01A	BI00308EB	Silver	0.400	MG/KG	U
VE	BRIN1	MESIC	MD01A	BI00308EB	Zinc	14.600	MG/KG	
VE	BRIN1	MESIC	MD02A	BI00287EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Chromium	0.700	MG/KG	
VE	BRIN1	MESIC	MD02A	BI00287EB	Copper	2.800	MG/KG	
VE	BRIN1	MESIC	MD02A	BI00287EB	Lead	0.300	MG/KG	I
VE	BRIN1	MESIC	MD02A	BI00287EB	Mercury	0.000	MG/KG	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Selenium	0.800	MG/KG	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Silver	0.400	MG/KG	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Zinc	12.700	MG/KG	
VE	BRIN1	MESIC	MR01A	BI00363EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Chromium	1.500	MG/KG	
VE	BRIN1	MESIC	MR01A	BI00363EB	Copper	2.200	MG/KG	
VE	BRIN1	MESIC	MR01A	BI00363EB	Lead	0.600	MG/KG	
VE	BRIN1	MESIC	MR01A	BI00363EB	Mercury	0.000	MG/KG	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Selenium	0.800	MG/KG	UI
VE	BRIN1	MESIC	MR01A	BI00363EB	Silver	0.400	MG/KG	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Zinc	14.000	MG/KG	
VE	BRIN1	MESIC	MR03A	BI00283EB	Cadmium	86.200	%	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Cadmium	0.300	MG/KG	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Chromium	91.800	%	
VE	BRIN1	MESIC	MR03A	BI00283EB	Chromium	1.000	MG/KG	
VE	BRIN1	MESIC	MR03A	BI00283EB	Copper	92.700	%	
VE	BRIN1	MESIC	MR03A	BI00283EB	Copper	2.000	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	BRIN1	MESIC	MR03A	BI00283EB	Lead	0.200	MG/KG	UI
VE	BRIN1	MESIC	MR03A	BI00283EB	Lead	93.800	%	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Mercury	0.100	MG/KG	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Selenium	5.300	MG/KG	
VE	BRIN1	MESIC	MR03A	BI00283EB	Selenium	-167.000	%	
VE	BRIN1	MESIC	MR03A	BI00283EB	Silver	80.500	%	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Silver	0.300	MG/KG	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Zinc	87.100	%	
VE	BRIN1	MESIC	MR03A	BI00283EB	Zinc	6.100	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00261EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Chromium	1.500	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00261EB	Copper	1.800	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00261EB	Lead	0.200	MG/KG	UI
VE	BRIN1	MESIC	MR04A	BI00261EB	Mercury	0.100	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Selenium	0.800	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Silver	0.400	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Zinc	24.000	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00515EB	Cadmium	0.400	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Chromium	2.000	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00515EB	Copper	1.900	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00515EB	Lead	0.200	MG/KG	I
VE	BRIN1	MESIC	MR04A	BI00515EB	Mercury	0.100	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Mercury	0.100	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Selenium	3.100	MG/KG	
VE	BRIN1	MESIC	MR04A	BI00515EB	Silver	0.400	MG/KG	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Zinc	22.500	MG/KG	
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Cadmium	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Chromium	0.600	MG/KG	
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Copper	9.900	MG/KG	
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Lead	0.500	MG/KG	I
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Mercury	0.100	MG/KG	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Selenium	0.800	MG/KG	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Silver	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Zinc	9.300	MG/KG	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Cadmium	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Chromium	37.800	MG/KG	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Copper	5.100	MG/KG	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Lead	0.700	MG/KG	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Mercury	0.000	MG/KG	U
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Selenium	0.900	MG/KG	U
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Silver	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Zinc	7.100	MG/KG	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Cadmium	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Chromium	0.600	MG/KG	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Copper	4.400	MG/KG	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Lead	0.500	MG/KG	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Mercury	0.100	MG/KG	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Selenium	0.800	MG/KG	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Silver	0.400	MG/KG	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Zinc	7.000	MG/KG	
VE	MEOF1	MESIC	MD01A	BI00310EB	Cadmium	0.400	MG/KG	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Chromium	0.600	MG/KG	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Copper	4.400	MG/KG	
VE	MEOF1	MESIC	MD01A	BI00310EB	Lead	0.400	MG/KG	I
VE	MEOF1	MESIC	MD01A	BI00310EB	Mercury	0.000	MG/KG	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Selenium	0.800	MG/KG	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Silver	0.500	MG/KG	
VE	MEOF1	MESIC	MD01A	BI00310EB	Zinc	5.200	MG/KG	
VE	MEOF1	MESIC	MD02A	BI00288EB	Cadmium	0.400	MG/KG	U
VE	MEOF1	MESIC	MD02A	BI00288EB	Chromium	0.900	MG/KG	
VE	MEOF1	MESIC	MD02A	BI00288EB	Copper	5.100	MG/KG	
VE	MEOF1	MESIC	MD02A	BI00288EB	Lead	0.400	MG/KG	I
VE	MEOF1	MESIC	MD02A	BI00288EB	Mercury	0.000	MG/KG	U
VE	MEOF1	MESIC	MD02A	BI00288EB	Selenium	0.800	MG/KG	U
VE	MEOF1	MESIC	MD02A	BI00288EB	Silver	0.400	MG/KG	U
VE	MEOF1	MESIC	MD02A	BI00288EB	Zinc	7.800	MG/KG	
VE	POCO1	HYDRIC	MA01A	BI00289EB	Cadmium	0.400	MG/KG	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Chromium	1.200	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	POCO1	HYDRIC	MA01A	BI00289EB	Copper	3.300	MG/KG	
VE	POCO1	HYDRIC	MA01A	BI00289EB	Lead	0.700	MG/KG	I
VE	POCO1	HYDRIC	MA01A	BI00289EB	Mercury	0.000	MG/KG	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Selenium	0.800	MG/KG	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Silver	0.400	MG/KG	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Zinc	13.600	MG/KG	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Cadmium	0.200	MG/KG	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Chromium	1.500	MG/KG	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Copper	1.700	MG/KG	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Lead	0.600	MG/KG	I
VE	POCO1	HYDRIC	MW03A	BI00312EB	Mercury	0.000	MG/KG	U
VE	POCO1	HYDRIC	MW03A	BI00312EB	Selenium	0.800	MG/KG	UI
VE	POCO1	HYDRIC	MW03A	BI00312EB	Silver	0.600	MG/KG	U
VE	POCO1	HYDRIC	MW03A	BI00312EB	Zinc	13.000	MG/KG	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Cadmium	0.200	MG/KG	U
VE	POCO1	HYDRIC	MW03R	BI00305EB	Chromium	1.500	MG/KG	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Copper	1.700	MG/KG	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Lead	0.600	MG/KG	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Mercury	0.000	MG/KG	U
VE	POCO1	HYDRIC	MW03R	BI00305EB	Selenium	0.800	MG/KG	UI
VE	POCO1	HYDRIC	MW03R	BI00305EB	Silver	0.600	MG/KG	U
VE	POCO1	HYDRIC	MW03R	BI00305EB	Zinc	12.600	MG/KG	
VE	POCO1	HYDRIC	MW04A	BI00344EB	Cadmium	0.200	MG/KG	U
VE	POCO1	HYDRIC	MW04A	BI00344EB	Chromium	0.900	MG/KG	U
VE	POCO1	HYDRIC	MW04A	BI00344EB	Copper	1.600	MG/KG	
VE	POCO1	HYDRIC	MW04A	BI00344EB	Lead	0.400	MG/KG	
VE	POCO1	HYDRIC	MW04A	BI00344EB	Mercury	0.100	MG/KG	U
VE	POCO1	HYDRIC	MW04A	BI00344EB	Selenium	0.700	MG/KG	UI
VE	POCO1	HYDRIC	MW04A	BI00344EB	Silver	0.500	MG/KG	U
VE	POCO1	HYDRIC	MW04A	BI00344EB	Zinc	14.200	MG/KG	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Americium 241	0.000	pCi/g	UX
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Americium 241	0.000	pCi/g	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Plutonium 238	0.000	pCi/g	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Plutonium 238	0.000	pCi/g	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Plutonium 239/240	0.001	pCi/g	BJ
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Plutonium 239/240	0.000	pCi/g	U
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Radium 226	0.000	pCi/g	
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Radium 226	0.000	pCi/g	
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Total Uranium	0.000	pCi/g	
AV	BRCA1	AQUATIC	SWC002	BI00525EB	Total Uranium	0.000	pCi/g	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Americium 241	-0.001	pCi/g	U
BM	CRAYF	AQUATIC	SW038	BI00501EB	Plutonium 238	-0.002	pCi/g	U
BM	CRAYF	AQUATIC	SW038	BI00501EB	Plutonium 239/240	0.018	pCi/g	J
BM	CRAYF	AQUATIC	SW038	BI00501EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	SW038	BI00501EB	Total Uranium	0.120	pCi/g	J
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Americium 241	0.002	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Plutonium 238	-0.001	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Plutonium 239/240	0.019	pCi/g	J
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00211EB	Total Uranium	0.000	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Americium 241	0.004	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Plutonium 238	0.000	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Plutonium 239/240	0.032	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00212EB	Total Uranium	0.000	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Americium 241	0.004	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Plutonium 238	-0.001	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Plutonium 239/240	0.006	pCi/g	U
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	SWC001	BI00500EB	Total Uranium	0.100	pCi/g	J
BM	CRAYF	AQUATIC	WOPO02	BI00496EB	Americium 241	-0.002	pCi/g	U
BM	CRAYF	AQUATIC	WOPO02	BI00496EB	Plutonium 238	0.000	pCi/g	U
BM	CRAYF	AQUATIC	WOPO02	BI00496EB	Plutonium 239/240	0.021	pCi/g	
BM	CRAYF	AQUATIC	WOPO02	BI00496EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	WOPO02	BI00496EB	Total Uranium	0.200	pCi/g	
BM	CRAYF	AQUATIC	WOPO02	BI00497EB	Americium 241	0.004	pCi/g	U
BM	CRAYF	AQUATIC	WOPO02	BI00497EB	Plutonium 238	0.001	pCi/g	U
BM	CRAYF	AQUATIC	WOPO02	BI00497EB	Plutonium 239/240	0.025	pCi/g	
BM	CRAYF	AQUATIC	WOPO02	BI00497EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	WOPO02	BI00497EB	Total Uranium	0.000	pCi/g	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Americium 241	0.000	pCi/g	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Plutonium 238	0.000	pCi/g	U
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Plutonium 239/240	0.024	pCi/g	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Radium 226	0.000	pCi/g	
BM	CRAYF	AQUATIC	WORI01	BI00487EB	Total Uranium	0.093	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00475EB	Americium 241	0.002	pCi/g	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Americium 241	0.000	pCi/g	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Plutonium 238	0.003	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00475EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Plutonium 239/240	0.000	pCi/g	U
FI	CACO1	AQUATIC	SW026	BI00475EB	Plutonium 239/240	0.008	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00475EB	Radium 226	8.500	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00475EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SW026	BI00475EB	Total Uranium	0.100	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00475EB	Total Uranium	0.071	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00476EB	Americium 241	0.003	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00476EB	Plutonium 238	0.010	pCi/g	U
FI	CACO1	AQUATIC	SW026	BI00476EB	Plutonium 239/240	0.015	pCi/g	J
FI	CACO1	AQUATIC	SW026	BI00476EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SW026	BI00476EB	Total Uranium	0.140	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00215EB	Americium 241	0.001	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00215EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00215EB	Plutonium 239/240	0.003	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00215EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00215EB	Total Uranium	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Americium 241	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Americium 241	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00216EB	Plutonium 239/240	0.001	pCi/g	J

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	CACO1	AQUATIC	SWC001	BI00216EB	Plutonium 239/240	0.001	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00216EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Total Uranium	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00216EB	Total Uranium	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Americium 241	0.001	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Americium 241	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	SWC001	BI00217EB	Plutonium 239/240	0.001	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00217EB	Plutonium 239/240	0.002	pCi/g	J
FI	CACO1	AQUATIC	SWC001	BI00217EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Total Uranium	0.000	pCi/g	
FI	CACO1	AQUATIC	SWC001	BI00217EB	Total Uranium	0.000	pCi/g	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Americium 241	0.001	pCi/g	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Plutonium 238	0.001	pCi/g	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Plutonium 239/240	0.000	pCi/g	U
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	WOPO02	BI00480EB	Total Uranium	0.150	pCi/g	J
FI	CACO1	AQUATIC	WORI01	BI00489EB	Americium 241	-0.001	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Plutonium 238	-0.001	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00489EB	Plutonium 239/240	0.004	pCi/g	J
FI	CACO1	AQUATIC	WORI01	BI00489EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	WORI01	BI00489EB	Total Uranium	0.190	pCi/g	J
FI	CACO1	AQUATIC	WORI01	BI00490EB	Americium 241	-0.003	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Plutonium 238	0.000	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Plutonium 239/240	0.001	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00490EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	WORI01	BI00490EB	Total Uranium	0.086	pCi/g	J
FI	CACO1	AQUATIC	WORI01	BI00491EB	Americium 241	0.000	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Plutonium 238	0.001	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Plutonium 239/240	0.001	pCi/g	U
FI	CACO1	AQUATIC	WORI01	BI00491EB	Radium 226	0.000	pCi/g	
FI	CACO1	AQUATIC	WORI01	BI00491EB	Total Uranium	0.094	pCi/g	J
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Americium 241	0.000	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Plutonium 238	0.000	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Plutonium 239/240	0.001	pCi/g	J
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Radium 226	0.000	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00504EB	Total Uranium	0.570	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Americium 241	0.001	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Plutonium 238	0.001	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Plutonium 239/240	0.007	pCi/g	J
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Radium 226	0.000	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00505EB	Total Uranium	0.620	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Americium 241	0.003	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Americium 241	0.001	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Plutonium 238	0.000	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Plutonium 238	0.000	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Plutonium 239/240	0.020	pCi/g	J
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Plutonium 239/240	0.003	pCi/g	U
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Radium 226	0.000	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Radium 226	0.000	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Total Uranium	0.400	pCi/g	
FI	FATHD	AQUATIC	RCSP01	BI00506EB	Total Uranium	0.380	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Americium 241	0.000	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00204EB	Plutonium 238	0.000	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00204EB	Plutonium 239/240	0.002	pCi/g	J
FI	LECY1	AQUATIC	SWC001	BI00204EB	Radium 226	0.000	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00204EB	Total Uranium	0.000	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00205EB	Americium 241	0.001	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Plutonium 238	0.000	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00205EB	Plutonium 239/240	0.001	pCi/g	J
FI	LECY1	AQUATIC	SWC001	BI00205EB	Radium 226	0.000	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00205EB	Total Uranium	0.000	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00206EB	Americium 241	0.000	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Plutonium 238	0.000	pCi/g	U
FI	LECY1	AQUATIC	SWC001	BI00206EB	Plutonium 239/240	0.002	pCi/g	J
FI	LECY1	AQUATIC	SWC001	BI00206EB	Radium 226	0.000	pCi/g	
FI	LECY1	AQUATIC	SWC001	BI00206EB	Total Uranium	0.000	pCi/g	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	MISA1	AQUATIC	SW005	BI00275EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Plutonium 239/240	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00275EB	Plutonium 239/240	0.001	pCi/g	J
FI	MISA1	AQUATIC	SW005	BI00275EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00275EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00275EB	Total Uranium	0.000	pCi/g	X
FI	MISA1	AQUATIC	SW005	BI00275EB	Total Uranium	0.000	pCi/g	X
FI	MISA1	AQUATIC	SW005	BI00276EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Americium 241	0.001	pCi/g	J
FI	MISA1	AQUATIC	SW005	BI00276EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Plutonium 239/240	0.001	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Plutonium 239/240	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00276EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00276EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00276EB	Total Uranium	0.000	pCi/g	X
FI	MISA1	AQUATIC	SW005	BI00276EB	Total Uranium	0.000	pCi/g	X
FI	MISA1	AQUATIC	SW005	BI00277EB	Americium 241	-0.001	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Plutonium 239/240	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Plutonium 239/240	0.000	pCi/g	U
FI	MISA1	AQUATIC	SW005	BI00277EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00277EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SW005	BI00277EB	Total Uranium	0.071	pCi/g	J
FI	MISA1	AQUATIC	SW005	BI00277EB	Total Uranium	0.084	pCi/g	J
FI	MISA1	AQUATIC	SWC001	BI00218EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SWC001	BI00218EB	Plutonium 239/240	0.001	pCi/g	J
FI	MISA1	AQUATIC	SWC001	BI00218EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SWC001	BI00218EB	Total Uranium	0.000	pCi/g	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Americium 241	0.000	pCi/g	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Plutonium 238	0.000	pCi/g	U
FI	MISA1	AQUATIC	SWC001	BI00219EB	Plutonium 239/240	0.001	pCi/g	J
FI	MISA1	AQUATIC	SWC001	BI00219EB	Radium 226	0.000	pCi/g	
FI	MISA1	AQUATIC	SWC001	BI00219EB	Total Uranium	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Americium 241	0.015	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Plutonium 238	0.001	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Plutonium 239/240	0.004	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00203EB	Total Uranium	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Americium 241	-0.001	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Plutonium 238	0.000	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Plutonium 239/240	0.008	pCi/g	J
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00213EB	Total Uranium	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Americium 241	0.001	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Plutonium 238	-0.001	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Plutonium 239/240	0.002	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00220EB	Total Uranium	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Americium 241	0.000	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Plutonium 238	0.000	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Plutonium 239/240	0.000	pCi/g	U
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	SWC001	BI00221EB	Total Uranium	0.000	pCi/g	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Americium 241	0.007	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Plutonium 238	0.000	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Plutonium 239/240	0.001	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	WORI01	BI00492EB	Total Uranium	0.100	pCi/g	J
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Americium 241	0.003	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Plutonium 238	-0.001	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Plutonium 239/240	0.001	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	WORI01	BI00493EB	Total Uranium	0.052	pCi/g	J

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Americium 241	-0.003	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Plutonium 238	0.001	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Plutonium 239/240	0.003	pCi/g	U
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Radium 226	0.000	pCi/g	
FI	NOCR1	AQUATIC	WORI01	BI00494EB	Total Uranium	0.150	pCi/g	J
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Americium 241	0.017	pCi/g	J
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Plutonium 238	0.000	pCi/g	U
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Plutonium 239/240	0.110	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Radium 226	0.000	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00472EB	Total Uranium	0.360	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Americium 241	0.017	pCi/g	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Plutonium 238	0.001	pCi/g	U
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Plutonium 239/240	0.110	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Radium 226	0.000	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00473EB	Total Uranium	0.390	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Americium 241	0.009	pCi/g	J
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Plutonium 238	0.001	pCi/g	U
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Plutonium 239/240	0.092	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Radium 226	0.000	pCi/g	
FI	PIPR1	AQUATIC	SWC002	BI00474EB	Total Uranium	0.390	pCi/g	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Americium 241	0.002	pCi/g	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Plutonium 238	-0.001	pCi/g	U
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Plutonium 239/240	0.034	pCi/g	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Radium 226	0.000	pCi/g	
FI	PIPR1	AQUATIC	WORI01	BI00488EB	Total Uranium	0.200	pCi/g	
FI	SEAT1	AQUATIC	SW026	BI00477EB	Americium 241	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Plutonium 238	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00477EB	Plutonium 239/240	0.003	pCi/g	J
FI	SEAT1	AQUATIC	SW026	BI00477EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SW026	BI00477EB	Total Uranium	0.240	pCi/g	
FI	SEAT1	AQUATIC	SW026	BI00478EB	Americium 241	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Plutonium 238	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Plutonium 239/240	0.002	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00478EB	Radium 226	24.000	pCi/g	
FI	SEAT1	AQUATIC	SW026	BI00478EB	Total Uranium	0.120	pCi/g	J
FI	SEAT1	AQUATIC	SW026	BI00479EB	Americium 241	0.011	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Plutonium 239/240	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW026	BI00479EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SW026	BI00479EB	Total Uranium	0.280	pCi/g	
FI	SEAT1	AQUATIC	SW033	BI00484EB	Americium 241	0.004	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Plutonium 238	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Plutonium 239/240	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00484EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SW033	BI00484EB	Total Uranium	0.250	pCi/g	
FI	SEAT1	AQUATIC	SW033	BI00485EB	Americium 241	0.002	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Plutonium 239/240	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00485EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SW033	BI00485EB	Total Uranium	0.120	pCi/g	J
FI	SEAT1	AQUATIC	SW033	BI00486EB	Americium 241	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Plutonium 238	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Plutonium 239/240	0.000	pCi/g	U
FI	SEAT1	AQUATIC	SW033	BI00486EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SW033	BI00486EB	Total Uranium	0.097	pCi/g	J
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Americium 241	0.005	pCi/g	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Plutonium 238	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Plutonium 239/240	0.001	pCi/g	U
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	SWC001	BI00210EB	Total Uranium	0.000	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Americium 241	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Plutonium 239/240	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00481EB	Total Uranium	0.290	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Americium 241	0.007	pCi/g	J
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Plutonium 239/240	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00482EB	Total Uranium	0.380	pCi/g	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Americium 241	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Americium 241	0.003	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Plutonium 238	0.002	pCi/g	J
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Plutonium 239/240	0.003	pCi/g	J
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Plutonium 239/240	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Total Uranium	0.310	pCi/g	
FI	SEAT1	AQUATIC	WOPO02	BI00483EB	Total Uranium	0.210	pCi/g	
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Americium 241	-0.003	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Plutonium 238	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Plutonium 239/240	0.001	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WORI03	BI00495EB	Total Uranium	0.057	pCi/g	J
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Americium 241	0.000	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Plutonium 238	-0.001	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Plutonium 239/240	0.002	pCi/g	J
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WORI03	BI00498EB	Total Uranium	0.094	pCi/g	J
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Americium 241	-0.002	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Plutonium 238	-0.002	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Plutonium 239/240	0.002	pCi/g	U
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Radium 226	0.000	pCi/g	
FI	SEAT1	AQUATIC	WORI03	BI00499EB	Total Uranium	0.170	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Americium 241	0.008	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Plutonium 238	0.001	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Plutonium 239/240	0.037	pCi/g	B
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Radium 226	0.000	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00233EB	Total Uranium	0.170	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Americium 241	0.007	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Plutonium 238	-0.001	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Plutonium 239/240	0.047	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Radium 226	0.000	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00234EB	Total Uranium	0.180	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Americium 241	0.009	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Plutonium 238	0.000	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Plutonium 239/240	0.037	pCi/g	B
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Radium 226	0.000	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00235EB	Total Uranium	0.120	pCi/g	J
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Americium 241	-0.001	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Plutonium 238	0.002	pCi/g	U
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Plutonium 239/240	0.053	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Radium 226	0.000	pCi/g	
HE	AMTI1	AQUATIC	SWC002	BI00237EB	Total Uranium	0.100	pCi/g	J
HE	THRA1	AQUATIC	SW003	BI00185EB	Americium 241	0.000	pCi/g	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Plutonium 238	0.000	pCi/g	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Plutonium 239/240	0.000	pCi/g	U
HE	THRA1	AQUATIC	SW003	BI00185EB	Radium 226	0.000	pCi/g	
HE	THRA1	AQUATIC	SW003	BI00185EB	Total Uranium	0.120	pCi/g	J
HE	THRA1	HYDRIC	MW03A	BI00174EB	Americium 241	0.009	pCi/g	J
HE	THRA1	HYDRIC	MW03A	BI00174EB	Plutonium 238	0.001	pCi/g	U
HE	THRA1	HYDRIC	MW03A	BI00174EB	Plutonium 239/240	0.051	pCi/g	B
HE	THRA1	HYDRIC	MW03A	BI00174EB	Radium 226	0.000	pCi/g	
HE	THRA1	HYDRIC	MW03A	BI00174EB	Total Uranium	0.280	pCi/g	
HE	THRA1	XERIC	MX01R	BI00299EB	Americium 241	0.000	pCi/g	U
HE	THRA1	XERIC	MX01R	BI00299EB	Americium 241	0.000	pCi/g	U
HE	THRA1	XERIC	MX01R	BI00299EB	Plutonium 238	0.000	pCi/g	U
HE	THRA1	XERIC	MX01R	BI00299EB	Plutonium 238	0.002	pCi/g	U
HE	THRA1	XERIC	MX01R	BI00299EB	Plutonium 239/240	0.007	pCi/g	BJ
HE	THRA1	XERIC	MX01R	BI00299EB	Plutonium 239/240	0.003	pCi/g	BJ
HE	THRA1	XERIC	MX01R	BI00299EB	Radium 226	0.000	pCi/g	
HE	THRA1	XERIC	MX01R	BI00299EB	Radium 226	0.000	pCi/g	
HE	THRA1	XERIC	MX01R	BI00299EB	Total Uranium	0.140	pCi/g	J
HE	THRA1	XERIC	MX01R	BI00299EB	Total Uranium	0.130	pCi/g	J
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Americium 241	0.001	pCi/g	J
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Plutonium 238	0.001	pCi/g	U
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Plutonium 239/240	0.002	pCi/g	J
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA01A	BI00191EB	Total Uranium	0.000	pCi/g	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Americium 241	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Plutonium 239/240	0.002	pCi/g	J
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA01A/3A	BI00524EB	Total Uranium	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Americium 241	0.002	pCi/g	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Plutonium 239/240	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA01R	BI00247EB	Total Uranium	0.170	pCi/g	J
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Americium 241	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Plutonium 239/240	0.003	pCi/g	J
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA02R	BI00248EB	Total Uranium	0.091	pCi/g	J
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Americium 241	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Plutonium 239/240	0.008	pCi/g	J
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA03A	BI00214EB	Total Uranium	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Americium 241	0.001	pCi/g	J
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Plutonium 239/240	0.001	pCi/g	J
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MA04R	BI00240EB	Total Uranium	0.082	pCi/g	J
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Americium 241	0.002	pCi/g	J
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Plutonium 239/240	0.000	pCi/g	U
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Radium 226	0.000	pCi/g	
SM	MIPE1	HYDRIC	MW02A	BI00232EB	Total Uranium	0.096	pCi/g	J
SM	MIPE1	MESIC	MD02A	BI00187EB	Americium 241	0.001	pCi/g	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	MESIC	MD02A	BI00187EB	Plutonium 239/240	0.003	pCi/g	J
SM	MIPE1	MESIC	MD02A	BI00187EB	Radium 226	0.000	pCi/g	
SM	MIPE1	MESIC	MD02A	BI00187EB	Total Uranium	0.000	pCi/g	
SM	MIPE1	MESIC	MG01A	BI00366EB	Americium 241	0.000	pCi/g	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	MESIC	MG01A	BI00366EB	Plutonium 239/240	0.003	pCi/g	J
SM	MIPE1	MESIC	MG01A	BI00366EB	Radium 226	0.000	pCi/g	
SM	MIPE1	MESIC	MG01A	BI00366EB	Total Uranium	0.090	pCi/g	J
SM	MIPE1	MESIC	MG04A	BI00353EB	Americium 241	0.086	pCi/g	
SM	MIPE1	MESIC	MG04A	BI00353EB	Plutonium 238	0.008	pCi/g	J
SM	MIPE1	MESIC	MG04A	BI00353EB	Plutonium 239/240	0.470	pCi/g	
SM	MIPE1	MESIC	MG04A	BI00353EB	Radium 226	0.000	pCi/g	
SM	MIPE1	MESIC	MG04A	BI00353EB	Total Uranium	0.110	pCi/g	J
SM	MIPE1	MESIC	MR02A	BI00364EB	Americium 241	0.000	pCi/g	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	MESIC	MR02A	BI00364EB	Plutonium 239/240	0.004	pCi/g	J
SM	MIPE1	MESIC	MR02A	BI00364EB	Radium 226	0.000	pCi/g	
SM	MIPE1	MESIC	MR02A	BI00364EB	Total Uranium	0.260	pCi/g	
SM	MIPE1	MESIC	MR04A	BI00354EB	Americium 241	0.001	pCi/g	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Plutonium 238	0.000	pCi/g	U
SM	MIPE1	MESIC	MR04A	BI00354EB	Plutonium 239/240	0.003	pCi/g	J
SM	MIPE1	MESIC	MR04A	BI00354EB	Radium 226	0.000	pCi/g	
SM	MIPE1	MESIC	MR04A	BI00354EB	Total Uranium	0.099	pCi/g	J
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Americium 241	0.000	pCi/g	UX
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Plutonium 238	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Plutonium 239/240	0.003	pCi/g	U
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MA02A	BI00173EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Americium 241	0.001	pCi/g	J
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Plutonium 239/240	0.001	pCi/g	J
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MA03R	BI00246EB	Total Uranium	0.088	pCi/g	J
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Americium 241	0.002	pCi/g	J
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Plutonium 238	-0.001	pCi/g	U
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Plutonium 239/240	0.008	pCi/g	J
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MA04A	BI00239EB	Total Uranium	0.120	pCi/g	J

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Americium 241	0.002	pCi/g	J
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Plutonium 238	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW01A	BI00189EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Americium 241	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Plutonium 239/240	0.002	pCi/g	J
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW01R	BI00242EB	Total Uranium	0.090	pCi/g	J
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Americium 241	0.001	pCi/g	J
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Plutonium 239/240	0.001	pCi/g	J
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW02R	BI00243EB	Total Uranium	0.100	pCi/g	J
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Americium 241	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Plutonium 239/240	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW03A	BI00188EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Americium 241	-0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Plutonium 238	0.001	pCi/g	J
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Plutonium 239/240	0.003	pCi/g	J
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW03R	BI00244EB	Total Uranium	0.096	pCi/g	J
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Americium 241	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Plutonium 239/240	0.001	pCi/g	U
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Radium 226	0.000	pCi/g	
SM	PEMA1	HYDRIC	MW04A	BI00186EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	MESIC	MD01A	BI00190EB	Americium 241	0.000	pCi/g	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Plutonium 238	0.006	pCi/g	U
SM	PEMA1	MESIC	MD01A	BI00190EB	Plutonium 239/240	0.026	pCi/g	
SM	PEMA1	MESIC	MD01A	BI00190EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MD01A	BI00190EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	MESIC	MD01B	BI00269EB	Americium 241	0.001	pCi/g	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	MESIC	MD01B	BI00269EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MD01B	BI00269EB	Total Uranium	0.084	pCi/g	J
SM	PEMA1	MESIC	MG01R	BI00267EB	Americium 241	-0.002	pCi/g	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Plutonium 238	0.001	pCi/g	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	MESIC	MG01R	BI00267EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MG01R	BI00267EB	Total Uranium	0.120	pCi/g	J
SM	PEMA1	MESIC	MG02R	BI00266EB	Americium 241	0.000	pCi/g	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Plutonium 238	-0.001	pCi/g	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	MESIC	MG02R	BI00266EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MG02R	BI00266EB	Total Uranium	0.110	pCi/g	J
SM	PEMA1	MESIC	MG03A	BI00365EB	Americium 241	0.003	pCi/g	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Plutonium 238	0.004	pCi/g	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Plutonium 239/240	0.010	pCi/g	U
SM	PEMA1	MESIC	MG03A	BI00365EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MG03A	BI00365EB	Total Uranium	0.000	pCi/g	
SM	PEMA1	MESIC	MG04R	BI00271EB	Americium 241	0.000	pCi/g	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Plutonium 238	-0.001	pCi/g	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	MESIC	MG04R	BI00271EB	Radium 226	0.000	pCi/g	
SM	PEMA1	MESIC	MG04R	BI00271EB	Total Uranium	0.140	pCi/g	J
SM	PEMA1	XERIC	MX01R	BI00268EB	Americium 241	0.001	pCi/g	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Plutonium 238	0.003	pCi/g	U
SM	PEMA1	XERIC	MX01R	BI00268EB	Plutonium 239/240	0.003	pCi/g	J
SM	PEMA1	XERIC	MX01R	BI00268EB	Radium 226	0.000	pCi/g	
SM	PEMA1	XERIC	MX01R	BI00268EB	Total Uranium	0.068	pCi/g	J
SM	PEMA1	XERIC	MX02R	BI00263EB	Americium 241	-0.001	pCi/g	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	XERIC	MX02R	BI00263EB	Radium 226	0.000	pCi/g	
SM	PEMA1	XERIC	MX02R	BI00263EB	Total Uranium	0.110	pCi/g	J

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
SM	PEMA1	XERIC	MX03R	BI00265EB	Americium 241	0.001	pCi/g	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Plutonium 238	0.000	pCi/g	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Plutonium 239/240	0.000	pCi/g	U
SM	PEMA1	XERIC	MX03R	BI00265EB	Radium 226	0.000	pCi/g	
SM	PEMA1	XERIC	MX03R	BI00265EB	Total Uranium	0.130	pCi/g	J
TA	ACRI	HYDRIC	MA01R	BI00328EB	Americium 241	0.002	pCi/g	U
TA	ACRI	HYDRIC	MA01R	BI00328EB	Plutonium 238	0.000	pCi/g	U
TA	ACRI	HYDRIC	MA01R	BI00328EB	Plutonium 239/240	0.015	pCi/g	BJ
TA	ACRI	HYDRIC	MA01R	BI00328EB	Radium 226	0.000	pCi/g	
TA	ACRI	HYDRIC	MA01R	BI00328EB	Total Uranium	0.000	pCi/g	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Americium 241	0.005	pCi/g	U
TA	ACRI	HYDRIC	MA04A	BI00241EB	Plutonium 238	C.006	pCi/g	U
TA	ACRI	HYDRIC	MA04A	BI00241EB	Plutonium 239/240	0.012	pCi/g	J
TA	ACRI	HYDRIC	MA04A	BI00241EB	Radium 226	0.000	pCi/g	
TA	ACRI	HYDRIC	MA04A	BI00241EB	Total Uranium	0.000	pCi/g	
TA	ACRI	HYDRIC	MW01A	BI00300EB	Americium 241	-0.001	pCi/g	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Plutonium 238	0.004	pCi/g	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Plutonium 239/240	0.003	pCi/g	U
TA	ACRI	HYDRIC	MW01A	BI00300EB	Radium 226	0.000	pCi/g	
TA	ACRI	HYDRIC	MW01A	BI00300EB	Total Uranium	0.042	pCi/g	J
TA	ACRI	HYDRIC	MW03R	BI00327EB	Americium 241	0.002	pCi/g	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Plutonium 238	0.000	pCi/g	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Plutonium 239/240	0.002	pCi/g	U
TA	ACRI	HYDRIC	MW03R	BI00327EB	Radium 226	0.000	pCi/g	
TA	ACRI	HYDRIC	MW03R	BI00327EB	Total Uranium	0.000	pCi/g	
TA	ACRI	MESIC	MD01A	BI00262EB	Americium 241	0.002	pCi/g	U
TA	ACRI	MESIC	MD01A	BI00262EB	Plutonium 238	0.008	pCi/g	U
TA	ACRI	MESIC	MD01A	BI00262EB	Plutonium 239/240	0.027	pCi/g	
TA	ACRI	MESIC	MD01A	BI00262EB	Radium 226	0.000	pCi/g	
TA	ACRI	MESIC	MD01A	BI00262EB	Total Uranium	0.000	pCi/g	
TA	ACRI	MESIC	MG03A	BI00249EB	Americium 241	0.021	pCi/g	
TA	ACRI	MESIC	MG03A	BI00249EB	Plutonium 238	-0.002	pCi/g	U
TA	ACRI	MESIC	MG03A	BI00249EB	Plutonium 239/240	0.033	pCi/g	
TA	ACRI	MESIC	MG03A	BI00249EB	Radium 226	0.000	pCi/g	
TA	ACRI	MESIC	MG03A	BI00249EB	Total Uranium	0.000	pCi/g	
TA	ACRI	MESIC	MG03R	BI00301EB	Americium 241	0.000	pCi/g	U
TA	ACRI	MESIC	MG03R	BI00301EB	Plutonium 238	0.000	pCi/g	U
TA	ACRI	MESIC	MG03R	BI00[illegible]1EB	Plutonium 239/240	0.001	pCi/g	BJ
TA	ACRI	MESIC	MG03R	BI00301EB	Radium 226	0.000	pCi/g	
TA	ACRI	MESIC	MG03R	BI00301EB	Total Uranium	0.000	pCi/g	
TA	ACRI	MESIC	MR03A	BI00302EB	Americium 241	0.002	pCi/g	U
TA	ACRI	MESIC	MR03A	BI00302EB	Plutonium 238	0.001	pCi/g	U
TA	ACRI	MESIC	MR03A	BI00302EB	Plutonium 239/240	0.001	pCi/g	U
TA	ACRI	MESIC	MR03A	BI00302EB	Radium 226	0.000	pCi/g	
TA	ACRI	MESIC	MR03A	BI00302EB	Total Uranium	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Americium 241	0.002	pCi/g	J
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Plutonium 239/240	0.011	pCi/g	J
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Radium 226	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW03A	BI00313EB	Total Uranium	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Americium 241	0.001	pCi/g	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Plutonium 239/240	0.000	pCi/g	U
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Radium 226	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW03R	BI00304EB	Total Uranium	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Americium 241	0.001	pCi/g	U
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Plutonium 239/240	0.002	pCi/g	J
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Radium 226	0.000	pCi/g	
VE	ARLU1	HYDRIC	MW04A	BI00345EB	Total Uranium	0.000	pCi/g	
VE	ARLU1	MESIC	MG02A	BI00318EB	Americium 241	0.002	pCi/g	BJ
VE	ARLU1	MESIC	MG02A	BI00318EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG02A	BI00318EB	Plutonium 239/240	0.001	pCi/g	U
VE	ARLU1	MESIC	MG02A	BI00318EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG02A	BI00318EB	Total Uranium	0.054	pCi/g	JX
VE	ARLU1	MESIC	MG02A	BI00520EB	Americium 241	0.002	pCi/g	BJ
VE	ARLU1	MESIC	MG02A	BI00520EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG02A	BI00520EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	ARLU1	MESIC	MG02A	BI00520EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG02A	BI00520EB	Total Uranium	0.000	pCi/g	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	ARLU1	MESIC	MG03A	BI00517EB	Americium 241	0.011	pCi/g	BJ
VE	ARLU1	MESIC	MG03A	BI00517EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG03A	BI00517EB	Plutonium 239/240	0.054	pCi/g	B
VE	ARLU1	MESIC	MG03A	BI00517EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG03A	BI00517EB	Total Uranium	0.046	pCi/g	JX
VE	ARLU1	MESIC	MG03A	BI00518EB	Americium 241	0.006	pCi/g	BJ
VE	ARLU1	MESIC	MG03A	BI00518EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG03A	BI00518EB	Plutonium 239/240	0.022	pCi/g	B
VE	ARLU1	MESIC	MG03A	BI00518EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG03A	BI00518EB	Total Uranium	0.000	pCi/g	
VE	ARLU1	MESIC	MG03R	BI00336EB	Americium 241	0.000	pCi/g	U
VE	ARLU1	MESIC	MG03R	BI00336EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG03R	BI00336EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	ARLU1	MESIC	MG03R	BI00336EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG03R	BI00336EB	Total Uranium	0.036	pCi/g	JX
VE	ARLU1	MESIC	MG04A	BI00256EB	Americium 241	0.011	pCi/g	BJ
VE	ARLU1	MESIC	MG04A	BI00256EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG04A	BI00256EB	Plutonium 239/240	0.051	pCi/g	B
VE	ARLU1	MESIC	MG04A	BI00256EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG04A	BI00256EB	Total Uranium	0.045	pCi/g	JX
VE	ARLU1	MESIC	MG04A	BI00523EB	Americium 241	0.003	pCi/g	BJ
VE	ARLU1	MESIC	MG04A	BI00523EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG04A	BI00523EB	Plutonium 239/240	0.014	pCi/g	BJ
VE	ARLU1	MESIC	MG04A	BI00523EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG04A	BI00523EB	Total Uranium	0.040	pCi/g	JX
VE	ARLU1	MESIC	MG04R	BI00280EB	Americium 241	-0.001	pCi/g	U
VE	ARLU1	MESIC	MG04R	BI00280EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MG04R	BI00280EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	ARLU1	MESIC	MG04R	BI00280EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MG04R	BI00280EB	Total Uranium	0.054	pCi/g	JX
VE	ARLU1	MESIC	MR02A	BI00320EB	Americium 241	0.003	pCi/g	BJ
VE	ARLU1	MESIC	MR02A	BI00320EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MR02A	BI00320EB	Plutonium 239/240	0.006	pCi/g	BJ
VE	ARLU1	MESIC	MR02A	BI00320EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MR02A	BI00320EB	Total Uranium	0.056	pCi/g	JX
VE	ARLU1	MESIC	MR03A	BI00282EB	Americium 241	0.005	pCi/g	BJ
VE	ARLU1	MESIC	MR03A	BI00282EB	Plutonium 238	0.001	pCi/g	J
VE	ARLU1	MESIC	MR03A	BI00282EB	Plutonium 239/240	0.001	pCi/g	U
VE	ARLU1	MESIC	MR03A	BI00282EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MR03A	BI00282EB	Total Uranium	0.086	pCi/g	JX
VE	ARLU1	MESIC	MR04A	BI00259EB	Americium 241	0.003	pCi/g	BJ
VE	ARLU1	MESIC	MR04A	BI00259EB	Plutonium 238	0.001	pCi/g	J
VE	ARLU1	MESIC	MR04A	BI00259EB	Plutonium 239/240	0.007	pCi/g	BJ
VE	ARLU1	MESIC	MR04A	BI00259EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MR04A	BI00259EB	Total Uranium	0.040	pCi/g	JX
VE	ARLU1	MESIC	MR04A	BI00516EB	Americium 241	0.022	pCi/g	BX
VE	ARLU1	MESIC	MR04A	BI00516EB	Americium 241	0.005	pCi/g	BJ
VE	ARLU1	MESIC	MR04A	BI00516EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MR04A	BI00516EB	Plutonium 238	0.000	pCi/g	U
VE	ARLU1	MESIC	MR04A	BI00516EB	Plutonium 239/240	0.006	pCi/g	BJ
VE	ARLU1	MESIC	MR04A	BI00516EB	Plutonium 239/240	0.008	pCi/g	BJ
VE	ARLU1	MESIC	MR04A	BI00516EB	Radium 226	0.000	pCi/g	
VE	ARLU1	MESIC	MR04A	BI00516EB	Radium 226	11.000	pCi/g	
VE	ARLU1	MESIC	MR04A	BI00516EB	Total Uranium	0.064	pCi/g	JX
VE	ARLU1	MESIC	MR04A	BI00516EB	Total Uranium	0.053	pCi/g	JX
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Americium 241	0.002	pCi/g	BJ
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Plutonium 238	0.000	pCi/g	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Plutonium 239/240	0.000	pCi/g	U
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Radium 226	0.000	pCi/g	
VE	ASFA1	HYDRIC	MA01R	BI00331EB	Total Uranium	0.047	pCi/g	JX
VE	BOGR1	MESIC	MG02A	BI00319EB	Americium 241	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG02A	BI00319EB	Plutonium 238	0.000	pCi/g	U
VE	BOGR1	MESIC	MG02A	BI00319EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG02A	BI00319EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG02A	BI00319EB	Total Uranium	0.036	pCi/g	JX
VE	BOGR1	MESIC	MG02A	BI00521EB	Americium 241	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG02A	BI00521EB	Plutonium 238	0.000	pCi/g	U
VE	BOGR1	MESIC	MG02A	BI00521EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG02A	BI00521EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG02A	BI00521EB	Total Uranium	0.042	pCi/g	JX

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	BOGR1	MESIC	MG03A	BI00341EB	Americium 241	0.013	pCi/g	BJ
VE	BOGR1	MESIC	MG03A	BI00341EB	Plutonium 238	0.002	pCi/g	J
VE	BOGR1	MESIC	MG03A	BI00341EB	Plutonium 239/240	0.048	pCi/g	B
VE	BOGR1	MESIC	MG03A	BI00341EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG03A	BI00341EB	Total Uranium	0.000	pCi/g	
VE	BOGR1	MESIC	MG03A	BI00519EB	Americium 241	0.014	pCi/g	BJ
VE	BOGR1	MESIC	MG03A	BI00519EB	Plutonium 238	0.002	pCi/g	J
VE	BOGR1	MESIC	MG03A	BI00519EB	Plutonium 239/240	0.045	pCi/g	B
VE	BOGR1	MESIC	MG03A	BI00519EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG03A	BI00519EB	Total Uranium	0.040	pCi/g	JX
VE	BOGR1	MESIC	MG03R	BI00333EB	Americium 241	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG03R	BI00333EB	Plutonium 238	0.000	pCi/g	U
VE	BOGR1	MESIC	MG03R	BI00333EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG03R	BI00333EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG03R	BI00333EB	Total Uranium	0.056	pCi/g	JX
VE	BOGR1	MESIC	MG04A	BI00255EB	Americium 241	0.023	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00255EB	Plutonium 238	0.002	pCi/g	J
VE	BOGR1	MESIC	MG04A	BI00255EB	Plutonium 239/240	0.091	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00255EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG04A	BI00255EB	Total Uranium	0.049	pCi/g	JX
VE	BOGR1	MESIC	MG04A	BI00522EB	Americium 241	0.088	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00522EB	Americium 241	0.120	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00522EB	Plutonium 238	0.001	pCi/g	J
VE	BOGR1	MESIC	MG04A	BI00522EB	Plutonium 238	0.001	pCi/g	J
VE	BOGR1	MESIC	MG04A	BI00522EB	Plutonium 239/240	0.110	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00522EB	Plutonium 239/240	0.120	pCi/g	B
VE	BOGR1	MESIC	MG04A	BI00522EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG04A	BI00522EB	Radium 226	11.000	pCi/g	
VE	BOGR1	MESIC	MG04A	BI00522EB	Total Uranium	0.038	pCi/g	JX
VE	BOGR1	MESIC	MG04A	BI00522EB	Total Uranium	0.038	pCi/g	JX
VE	BOGR1	MESIC	MG04R	BI00281EB	Americium 241	0.001	pCi/g	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Americium 241	-0.001	pCi/g	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Plutonium 238	0.000	pCi/g	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Plutonium 238	0.000	pCi/g	U
VE	BOGR1	MESIC	MG04R	BI00281EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG04R	BI00281EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BOGR1	MESIC	MG04R	BI00281EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG04R	BI00281EB	Radium 226	0.000	pCi/g	
VE	BOGR1	MESIC	MG04R	BI00281EB	Total Uranium	0.037	pCi/g	JX
VE	BOGR1	MESIC	MG04R	BI00281EB	Total Uranium	0.046	pCi/g	JX
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Americium 241	0.001	pCi/g	U
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Plutonium 238	0.001	pCi/g	J
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Plutonium 239/240	0.000	pCi/g	U
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Radium 226	0.000	pCi/g	
VE	BRIN1	HYDRIC	MA01R	BI00329EB	Total Uranium	0.000	pCi/g	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Americium 241	0.001	pCi/g	U
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Plutonium 239/240	0.001	pCi/g	J
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Radium 226	0.000	pCi/g	
VE	BRIN1	HYDRIC	MA04A	BI00325EB	Total Uranium	0.000	pCi/g	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Americium 241	-0.001	pCi/g	U
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Plutonium 239/240	0.002	pCi/g	J
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Radium 226	0.000	pCi/g	
VE	BRIN1	HYDRIC	MW01A	BI00293EB	Total Uranium	0.059	pCi/g	J
VE	BRIN1	MESIC	MD01A	BI00308EB	Americium 241	0.001	pCi/g	BJ
VE	BRIN1	MESIC	MD01A	BI00308EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MD01A	BI00308EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BRIN1	MESIC	MD01A	BI00308EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MD01A	BI00308EB	Total Uranium	0.057	pCi/g	JX
VE	BRIN1	MESIC	MD02A	BI00287EB	Americium 241	0.001	pCi/g	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MD02A	BI00287EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	BRIN1	MESIC	MD02A	BI00287EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MD02A	BI00287EB	Total Uranium	0.000	pCi/g	
VE	BRIN1	MESIC	MR01A	BI00363EB	Americium 241	0.000	pCi/g	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Plutonium 239/240	0.000	pCi/g	U
VE	BRIN1	MESIC	MR01A	BI00363EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MR01A	BI00363EB	Total Uranium	0.000	pCi/g	

SAMPLE TYPE	SPECIES	COMMUNITY TYPE	LOCATION	PROJECT SAMPLE NO	ANALYTE	RESULTS	UNITS	QUALIFIER
VE	BRIN1	MESIC	MR03A	BI00283EB	Americium 241	0.001	pCi/g	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Plutonium 239/240	0.000	pCi/g	U
VE	BRIN1	MESIC	MR03A	BI00283EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MR03A	BI00283EB	Total Uranium	0.000	pCi/g	
VE	BRIN1	MESIC	MR04A	BI00261EB	Americium 241	0.001	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Plutonium 239/240	0.000	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00261EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MR04A	BI00261EB	Total Uranium	0.000	pCi/g	
VE	BRIN1	MESIC	MR04A	BI00515EB	Americium 241	-0.001	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Plutonium 238	0.000	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Plutonium 239/240	0.001	pCi/g	U
VE	BRIN1	MESIC	MR04A	BI00515EB	Radium 226	0.000	pCi/g	
VE	BRIN1	MESIC	MR04A	BI00515EB	Total Uranium	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Americium 241	0.000	pCi/g	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Plutonium 238	0.000	pCi/g	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Plutonium 239/240	0.000	pCi/g	U
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Radium 226	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA01A	BI00290EB	Total Uranium	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Americium 241	0.002	pCi/g	J
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Plutonium 238	0.000	pCi/g	U
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Plutonium 239/240	0.008	pCi/g	J
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Radium 226	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA02A	BI00311EB	Total Uranium	1.300	pCi/g	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Americium 241	0.001	pCi/g	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Americium 241	-0.001	pCi/g	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Plutonium 238	0.001	pCi/g	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Plutonium 238	0.000	pCi/g	U
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Plutonium 239/240	0.004	pCi/g	J
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Plutonium 239/240	0.003	pCi/g	J
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Radium 226	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Radium 226	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Total Uranium	0.000	pCi/g	
VE	MEOF1	HYDRIC	MA03A	BI00323EB	Total Uranium	0.000	pCi/g	
VE	MEOF1	MESIC	MD01A	BI00310EB	Americium 241	-0.001	pCi/g	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Plutonium 238	0.000	pCi/g	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Plutonium 239/240	0.000	pCi/g	U
VE	MEOF1	MESIC	MD01A	BI00310EB	Radium 226	0.000	pCi/g	
VE	MEOF1	MESIC	MD01A	BI00310EB	Total Uranium	0.043	pCi/g	JX
VE	MEOF1	MESIC	MD02A	BI00288EB	Americium 241	0.002	pCi/g	U
VE	MEOF1	MESIC	MD02A	BI00288EB	Plutonium 238	0.002	pCi/g	J
VE	MEOF1	MESIC	MD02A	BI00288EB	Plutonium 239/240	0.001	pCi/g	BJ
VE	MEOF1	MESIC	MD02A	BI00288EB	Radium 226	0.000	pCi/g	
VE	MEOF1	MESIC	MD02A	BI00288EB	Total Uranium	0.039	pCi/g	JX
VE	POCO1	HYDRIC	MA01A	BI00289EB	Americium 241	0.000	pCi/g	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Plutonium 238	0.000	pCi/g	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Plutonium 239/240	0.000	pCi/g	U
VE	POCO1	HYDRIC	MA01A	BI00289EB	Radium 226	0.000	pCi/g	
VE	POCO1	HYDRIC	MA01A	BI00289EB	Total Uranium	0.000	pCi/g	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Americium 241	0.000	pCi/g	U
VE	POCO1	HYDRIC	MW03A	BI00312EB	Plutonium 238	-0.001	pCi/g	U
VE	POCO1	HYDRIC	MW03A	BI00312EB	Plutonium 239/240	0.002	pCi/g	J
VE	POCO1	HYDRIC	MW03A	BI00312EB	Radium 226	0.000	pCi/g	
VE	POCO1	HYDRIC	MW03A	BI00312EB	Total Uranium	0.000	pCi/g	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Americium 241	0.002	pCi/g	J
VE	POCO1	HYDRIC	MW03R	BI00305EB	Plutonium 238	0.000	pCi/g	U
VE	POCO1	HYDRIC	MW03R	BI00305EB	Plutonium 239/240	0.001	pCi/g	J
VE	POCO1	HYDRIC	MW03R	BI00305EB	Radium 226	0.000	pCi/g	
VE	POCO1	HYDRIC	MW03R	BI00305EB	Total Uranium	0.000	pCi/g	
VE	POCO1	HYDRIC	MW04A	BI00344EB	Americium 241	0.001	pCi/g	J
VE	POCO1	HYDRIC	MW04A	BI00344EB	Plutonium 238	0.000	pCi/g	U
VE	POCO1	HYDRIC	MW04A	BI00344EB	Plutonium 239/240	0.003	pCi/g	J
VE	POCO1	HYDRIC	MW04A	BI00344EB	Radium 226	0.000	pCi/g	
VE	POCO1	HYDRIC	MW04A	BI00344EB	Total Uranium	0.000	pCi/g	

ATTACHMENT E-4

AQUATIC TOXICITY SCREEN DATA

Note: This attachment contains data from two reports on aquatic toxicity screens conducted in 1991. The report dated November 13, 1991 includes data on samples taken from the B-series retention ponds. The B-series ponds were sampled in conjunction with other activities at Rocky Flats, not to support the OU1 EE. The total report is included for the sake of completeness.

T.H.E. LABORATORIES, INC.

Technical & Analytical Specialists

325 Interlocken Parkway, Suite 205 • Broomfield, Colorado 80021
(303) 438-0970 • FAX (303) 438-0971

August 11, 1991

Mr. Mark Lewis
S.M. Stoller Corporation
5700 Flatirons Parkway
Boulder, Colorado 80301

Dear Mark:

I am pleased to submit the results of the acute screening biomonitoring tests for the Rocky Flats samples collected August 1, 1991. Most of the samples with a couple exceptions had a measurable and significant effect on the *Ceriodaphnia*. Only two of the samples had an effect on the fathead minnows. I am not able to determine the cause of toxicity but, given the patterns of toxicity, my first estimate would be that metals may be a contributor. However, that is purely speculative and in at least one case, it could be that other contaminants may be at fault. A TRE would be required to isolate the causes of toxicity.

Please feel free to contact me if you have any questions.

Sincerely,

Ken Fucik

enclosure

BIOMONITORING RESULTS FROM EG&G'S ROCKY FLATS PLANT

Submitted to:

Mr. Mark Lewis
S.M. Stoller Corporation
5700 Flatirons Parkway
Boulder, Colorado 80301

Submitted by:

T.H.E. Laboratories, Inc.
325 Interlocken Parkway
Suite 205
Broomfield, Colorado 80021
(303) 438-0970

August 9, 1991

ACUTE TOXICITY TEST SUMMARY

Test: 48-hour static renewal using *Ceriodaphnia* sp. and 96-hour static renewal using fathead minnows (*Pimephales promelas*).

Client: EG&G, Rocky Flats Plant

Test Procedure Followed: Peltier and Weber (1985)

Sample Description:

BIO2050ST	SW005
BIO2051ST	SW104
BIO2052ST	SW041
BIO2053ST	SW039
BIO2054ST	SW033
BIO2055ST	SW032
BIO2056ST	WORI3
BIO2057ST	WORI3
BIO2058ST	WORI1
BIO2059ST	WOPO2
BIO2060ST	WOPO2

Dates of Sample Collection: August 1, 1991

Date of Sample Receipt: August 1, 1991

Dilution Water: Reconstituted water

Test Organism Source: *Ceriodaphnia* - T.H.E. Consultants
fathead minnows - T.H.E. Consultants

Reference Toxicant: Sodium Dodecyl Sulfate

ABSTRACT OF RESULTS

Test Concentrations: Control, 100%

Number of organisms in each concentration: 20

Replicates at each concentration: 4

	Ceriodaphnia	Fathead minnows
Test vessel size:	30 ml	260 ml
Exposure volume:	15 ml	200 ml
No. Survivors:		
BIO2050ST	5	16
BIO2051ST	12	10
BIO2052ST	7	20
BIO2053ST	10	18
BIO2054ST	5	18
BIO2055ST	10	20
BIO2056ST	11	19
BIO2057ST	11	20
BIO2058ST	15	19
BIO2059ST	17	19
BIO2060ST	5	11
Temperature range during test (°C):		
BIO2050ST	19.3-22.1	19.0-21.1
BIO2051ST	19.4-22.1	19.6-21.0
BIO2052ST	19.3-22.2	19.6-20.9
BIO2053ST	18.5-22.1	19.0-21.2
BIO2054ST	19.3-22.0	19.5-21.0
BIO2055ST	19.2-21.9	19.6-21.0
BIO2056ST	19.0-22.1	19.1-21.0
BIO2057ST	18.9-22.1	19.4-21.4
BIO2058ST	18.9-22.2	19.6-20.8
BIO2059ST	19.0-22.2	19.6-21.0
BIO2060ST	19.2-22.6	19.7-21.0
Dissolved oxygen range (ml/l):		
BIO2050ST	6.5-7.0	4.9-7.2
BIO2051ST	6.6-6.9	5.1-7.4
BIO2052ST	6.7-6.8	3.8-7.1
BIO2053ST	6.6-6.9	5.1-7.3
BIO2054ST	6.6-6.9	5.0-7.2

BIO2055ST	6.8-6.9	5.0-7.3
BIO2056ST	6.7-7.1	4.6-7.3
BIO2057ST	6.8-7.0	3.9-6.8
BIO2058ST	6.7-6.9	4.0-7.2
BIO2059ST	6.7-7.0	4.2-7.2
BIO2060ST	6.6-7.1	4.2-7.3
pH range during test:		
BIO2050ST	7.2-8.5	6.7-7.1
BIO2051ST	7.8-8.5	7.0-7.5
BIO2052ST	7.7-8.5	7.2-7.6
BIO2053ST	7.8-8.5	7.2-7.6
BIO2054ST	8.1-8.7	7.3-7.8
BIO2055ST	8.3-8.7	7.5-8.0
BIO2056ST	8.1-8.6	7.6-7.8
BIO2057ST	8.1-8.6	7.3-7.7
BIO2058ST	8.0-8.6	7.5-7.9
BIO2059ST	7.6-8.6	7.3-8.0
BIO2060ST	7.3-8.5	7.0-7.9

	Control	**100% Effluent**
Alkalinity (mg/l as $CaCO_3$)		
BIO2050ST	110	96
BIO2051ST	110	88
BIO2052ST	110	87
BIO2053ST	110	90
BIO2054ST	110	138
BIO2055ST	110	136
BIO2056ST	110	138
BIO2057ST	110	154
BIO2058ST	110	200
BIO2059ST	110	290
BIO2060ST	110	9
Hardness (mg/l as $CaCO_3$)		
BIO2050ST	131	66
BIO2051ST	131	108
BIO2052ST	131	108
BIO2053ST	131	86
BIO2054ST	131	124
BIO2055ST	131	120
BIO2056ST	131	150
BIO2057ST	131	136
BIO2058ST	131	202
BIO2059ST	131	220

BIO2060ST	131	4
Total ammonia in sample (mg/l)		
BIO2050ST	ND	ND
BIO2051ST	ND	ND
BIO2052ST	ND	ND
BIO2053ST	ND	ND
BIO2054ST	ND	ND
BIO2055ST	ND	ND
BIO2056ST	ND	ND
BIO2057ST	ND	ND
BIO2058ST	ND	ND
BIO2059ST	ND	ND
BIO2060ST	ND	ND
Total chlorine (mg/l)		
BIO2050ST	ND	ND
BIO2051ST	ND	ND
BIO2052ST	ND	ND
BIO2053ST	ND	ND
BIO2054ST	ND	ND
BIO2055ST	ND	ND
BIO2056ST	ND	ND
BIO2057ST	ND	ND
BIO2058ST	ND	ND
BIO2059ST	ND	ND
BIO2060ST	ND	ND

INTRODUCTION

EG&G's Rocky Flats Plant performs whole effluent toxicity tests on various surface waters on the plant property. The purpose of this testing is to monitor water quality of the surface waters on the plant property. To accomplish this goal, a series of samples were collected during July, 1991 and used in acute screening biomonitoring exposures.

The biomonitoring tests used *Ceriodaphnia* sp., an invertebrate, and fathead minnows (*Pimephales promelas*). Biomonitoring procedures used for testing followed the protocols outlined in Peltier and Weber (1985). These test procedures are consistent with the Colorado Water Quality Control Division and Environmental Protection Agency Region VIII guidelines for biomonitoring. The results of the biomonitoring tests are presented in the following sections.

MATERIALS AND METHODS

Grab samples were collected in one gallon plastic containers on August 1 at eleven stations. Sampling times and locations are summarized in Table 1. All samples were delivered to T.H.E. Consultant's lab in ice chests where they were refrigerated at 4°C until testing. Chain of custody forms showing collection and lab arrival times for each sampling period are provided in Appendix 1.

Prior to testing, the samples were analyzed for hardness, alkalinity, conductivity, ammonia, pH, and dissolved oxygen. Hardness and alkalinity were determined titrimetrically. Ammonia was also measured with an Orion ion selective electrode. Methods followed those described in APHA (1985). Conductivity, dissolved oxygen, and pH were measured with probes after calibration of instruments.

The full strength effluent sample and a control were used for testing the *Ceriodaphnia* sp. and fathead minnows. Reconstituted water was used as the source of dilution water and a control.

Less than 24 hour old *Ceriodaphnia* and four day old minnows were used. The organisms came from T.H.E.'s in-house cultures. These animals are tested monthly in a reference toxicant test using sodium dodecyl sulfate.

Ceriodaphnia were exposed to the various effluent concentrations for 48 hours. Fathead minnow tests were run for 96 hours. The exposure medium was replaced after each 24 hour period and the number of surviving organisms counted and recorded. Routine measurements of pH, temperature, and dissolved oxygen were made for each 24 hour period prior to and after water was changed. Tests were run in an environmental chamber programmed for a

Table 1. Summary of sample collection times and station designations.

STATION	DATE OF COLLECTION	STATION ACRONYM
BIO2050ST	8/1/91	SW005
BIO2051ST	8/1/91	SW104
BIO2052ST	8/1/91	SW041
BIO2053ST	8/1/91	SW039
BIO2054ST	8/1/91	SW033
BIO2055ST	8/1/91	SW032
BIO2056ST	8/1/91	WORI3
BIO2057ST	8/1/91	WORI3
BIO2058ST	8/1/91	WORI1
BIO2059ST	8/1/91	WOPO2
BIO2060ST	8/1/91	WOPO2

16 hr light/8 hr dark cycle and maintained at 20°C.

RESULTS

The results of the biomonitoring tests are summarized in Table 2 and presented in detail on the lab data sheets in Appendix 2. Six of the samples in the *Ceriodaphnia* test showed a significant toxicity which would have resulted in an LC50. Of the remaining samples, only two produced 15 or more survivors. By comparison, an acute effect to fathead minnows was measured only in two samples with one sample producing an LC50. The other sample had 11 survivors. Most of the remaining samples had 18-20 survivors which would indicate a lack of sensitivity to the water samples.

DISCUSSION

The samples showed a significant amount of toxicity overall with most of the effects restricted to the ceriodaphs. The cause of the toxicity is not readily apparent although the greater sensitivity of the ceriodaphs can sometimes be traced to trace metals or total dissolved solids (TDS). This latter contaminant, however, does not appear to be present in significant levels given the generally low conductivities. The WOPO2 (BIO2060ST) sample had physico-chemical characteristics (i.e. hardness, alkalinity, and conductivity) similar to that of a distilled water. Such water does not typically produce good survival in the present test organisms.

The SW104 sample produced somewhat different results from the other samples with an almost equivalent toxicity in the two test species. Based on our experience, this would seem to suggest that a different contaminant was active than that seen in the other samples where effects were observed. We have observed some organic contaminants to produce such effects in the two test species.

Nevertheless, it should be noted that all of the above is speculative and would require additional testing in order to definitively identify the cause of the measured toxicities. This can usually be accomplished through the conduct of a toxicity reduction evaluation.

REFERENCES

APHA/AWWA/WPCF. 1985. Standard methods for the examination of water and wastewater. 16th Edition. American Public Health Association. 1268 pp.

Peltier, W.H. and C.I. Weber. 1985. Methods for measuring the acute toxicity of effluents to freshwater and marine organisms (third edition). Environmental Protection Agency Report No. EPA 600/4-85/013. 216 pp.

Table 2. Summary of surviving organisms at each sampling station collected on August 1., 1991. Each test began with 20 animals.

STATION	*CERIODAPHNIA*	FATHEAD MINNOWS
Control	19	20
SW005	5	16
SW104	12	10
SW041	7	20
SW039	10	18
SW033	5	18
SW032	10	20
WORI3 (BIO02056ST)	11	19
WORI3 (BIO02057ST)	11	20
WORI1	15	19
WOPO2 (BIO02059ST)	17	19
WOPO2 (BIO02060ST)	5	11

Appendix 1. Chain of Custody Form

U22491

CONTRACTOR J.M. Stoller Corp. SAMPLERS Don Reeder, John Boylan PROJECT # 6504

SITE CONTACT/PHONE Mark Lewis 449-7220 LAB/LOCATION THE Consultants - Broomfield, CO

C-O-C NUMBER ST-THEC-0001

EG&G ROCKY FLATS PLANT
CHAIN OF CUSTODY

DATE	TIME	SAMPLE NUMBER	LOCATION	CONTAINER TYPE	NUMBER OF CONTAINERS	MEDIA SOIL(S) WATER (W)	FILTERED=F POT DISS=P	TURN AROUND RUSH =R	OUT OF SPEC REPORTS REQUIRED	PRESERVATIVE: COOLED TO 4 C Y/N	Zn(C2H3O2)2	NAOH	HNO3	H2SO4	Na2S2O3	Toxicity
8/1/91	0951	BI020505T	SW005	1gallon Plastic	1	W				Y						X
11	1026	BI020515T	SW104	11	1	W				Y						X
11	1119	BI020525T	SW041	11	1	W				Y						X
11	1126	BI020535T	SW039	11	1	W				Y						X
11	1148	BI020545T	SW033	11	1	W				Y						X
11	1155	BI020555T	SW032	11	1	W				Y						X
11	1222	BI020565T	WORI3	11	1	W				Y						X
11	1222	BI020575T	WORI3	11	1	W				Y						X
11	1238	BI020585T	WORI1	11	1	W				Y						X
11	1321	BI020595T	WOPO2	11	1	W				Y						X
11	1336	BI020605T	WOPO2	11	1	W				Y						X

RELINQUISHED BY	DATE/TIME		RECEIVED BY	DATE/TIME	
John Boylan	08/01/91	1541	Don Fish	8-1-91	15:41

REMARKS

SHIPMENT METHOD

LABORATORY USE ONLY	Y / N
PCKG REC'D/CUSTODY SEALS INTACT	Y
SAMPLE LABELS/COCs AGREE	Y
TEMPERATURE WITHIN SPECIFICATION ____ C	Iced
CORRECTED COPY ATTACHED	
OTHER PROBLEMS OR DISCREPANCIES	

Appendix 2. Lab Data Sheets

SW005

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ______ OUTFALL: B102050S1

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 0951 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100%	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	16				
AFTER 48 HRS:	18	5				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.2/6.8	7.0/6.5	/	/	/	/
TEMPERATURE °C:	22.2/19.6	22.1/19.3	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ______ EFFLUENT 66 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ______ EFFLUENT 96 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 7.2 FINAL - CONTROL 8.6 100% 8.5

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS: ______

[signature] 8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B102050ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 09:51 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	18				
AFTER 96 HRS:	20	16				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.2/4.9	/	/	/	/
TEMPERATURE °C:	20.8/18.8	21.1/19.0	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 66 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 96 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.1 FINAL - CONTROL 7.0 100% 7.0

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS: ____

Wm Jiner 8/12/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats ______ CDPS NO. CO-00__________ OUTFALL: B-0205 1ST

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1026 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100%	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	19				
AFTER 48 HRS:	18	11				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.1/6.6	7.1/6.7	/	/	/	/
TEMPERATURE °C:	22.6/19.2	22.1/19.0	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ______ EFFLUENT 108 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ______ EFFLUENT 88 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 7.8 FINAL - CONTROL 8.6 100% 8.5

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS: ______

NM [signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B1020S1ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 100 %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 10:26 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	18				
AFTER 72 HRS:	20	16				
AFTER 96 HRS:	20	10				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.4/5.1	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.0/19.6	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 108 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 88 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.5 FINAL - CONTROL 7.0 100% 7.2

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B102 T

TYPE TEST: ROUTINE: ✓ ACCELERATED: ___ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

---

TEST RESULTS: IWC: ___ % CONTROL MORTALITY: 10 % LC50: ___ %

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ___ %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1119 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	18				
AFTER 48 HRS:	18	7				
AFTER 72 HRS:						
AFTER 96 HRS:						

MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	6.8/6.7	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.2/19.3	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ___ EFFLUENT 108 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ___ EFFLUENT 87 RECON/LAB WATER 110

PH: INITIAL - CONTROL ~~7.9~~ 8.2 100% ~~8.2~~ 7.7 FINAL - CONTROL 8.6 100% 8.5

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.A.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/12/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ________ OUTFALL: B102052ST

TYPE TEST: ROUTINE: 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 11:19 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	20				
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.1/3.8	/	/	/	/
TEMPERATURE °C:	20.8/19.8	20.9/19.6	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 108 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 87 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.5 FINAL - CONTROL 7.0 100% 7.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ________ OUTFALL: B10[illegible]

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 10 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ________%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1126 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	17				
AFTER 48 HRS:	18	10				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.0 / 6.8	6.9 / 6.6	/	/	/	/
TEMPERATURE °C:	22.7 / 19.6	22.1 / 18.5	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ________ EFFLUENT 86 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ________ EFFLUENT 90 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 7.8 FINAL - CONTROL 8.6 100% 8.5

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[illegible] 8/12/91 1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B102053 ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 11:26 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	19				
AFTER 96 HRS:	20	18				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.3/5.1	/	/	/	/
TEMPERATURE °C:	20.8/18.8	21.2/19.0	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 86 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 90 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.6 FINAL - CONTROL 7.0 100% 7.2

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00______ OUTFALL: B102C

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1148 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	16				
AFTER 48 HRS:	18	5				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	6.9/6.6	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.0/19.3	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ______ EFFLUENT 124 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ______ EFFLUENT 138 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 8.1 FINAL - CONTROL 8.6 100% 8.7

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.A.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00__________ OUTFALL: B1020545T

TYPE TEST: ROUTINE: 100% Screen ✓ ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 0 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 11:48 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	18				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.2/5.0	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.0/19.5	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 124 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 138 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.8 FINAL - CONTROL 7.0 100% 7.3

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B102

TYPE TEST: ROUTINE: ✓ ACCELERATED: ___ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ___% CONTROL MORTALITY: 10 % LC50: ___%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ___%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1155 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	~~15~~ 19 KF				
AFTER 48 HRS:	18	10 KF				
AFTER 72 HRS:						
AFTER 96 HRS:						

MAX/MIN VALUES

DISSOLVED OXYGEN, MG/L:	7.0 / 6.8	~~7.1~~ 6.9 / 6.8	/	/	/	/
TEMPERATURE °C:	22.7 / 19.6	~~22.6~~ 21.9 / 19.2	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ___ EFFLUENT 120 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ___ EFFLUENT 136 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 8.3 FINAL - CONTROL 8.6 100% 8.7

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.A.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/2/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00________ OUTFALL: B102055ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4days

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 0 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____________%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 11:55 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
		DILUTIONS (% EFFLUENT)				
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	20				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.3/5.0	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.0/19.6	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 120 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 136 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.9 FINAL - CONTROL 7.0 100% 7.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS: ____________________

8/12/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00________ OUTFALL: B1020?

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1222 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100%	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	19				
AFTER 48 HRS:	18	11				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	7.1/6.7	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.1/19.0	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER________ EFFLUENT 150 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER________ EFFLUENT 138 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 8.1 FINAL - CONTROL 8.6 100% 8.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ______ OUTFALL: B102056ST

TYPE TEST: ROUTINE: ✓ 100% Screen ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 12:22 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	19				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0 / 4.6	7.3 / 4.6	/	/	/	/
TEMPERATURE °C:	20.8 / 19.8	21.0 / 19.1	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 150 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 138 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.8 FINAL - CONTROL 7.0 100% 7.7

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS: ______

8/12/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B0205

TYPE TEST: ROUTINE: ✓ ACCELERATED: ___ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ___ % CONTROL MORTALITY: 10 % LC50: ___ %

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ___ %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1222 AM/PM 8/1/91

TEST TIME & DATE: BEGIN ___ AM/PM 8/1/91 END ___ AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	18				
AFTER 48 HRS:	18	11				
AFTER 72 HRS:						
AFTER 96 HRS:						

MAX/MIN VALUES

DISSOLVED OXYGEN, MG/L:	7.0/6.8	7.0/6.8	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.1/18.9	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ___ EFFLUENT 136 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ___ EFFLUENT 154 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 8.1 FINAL - CONTROL 8.6 100% 8.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.A.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ________ OUTFALL: B102057ST

TYPE TEST: 100% Screen ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ________%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 12:22 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	20				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	6.8/3.9	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.4/19.4	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 136 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 154 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.7 FINAL - CONTROL 7.0 100% 7.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

[signature] 8/12/91 1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B1020

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24hrs

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 10 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1238 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100%	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	19				
AFTER 48 HRS:	18	15				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	6.9/6.7	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.2/18.9	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ____ EFFLUENT ____ RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ____ EFFLUENT ____ RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 8.0 FINAL - CONTROL 8.6 100% 8.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ________ OUTFALL: B1020S8ST

TYPE TEST: 100% Screen ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 12:38 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	19				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.2/4.0	/	/	/	/
TEMPERATURE °C:	20.8/19.8	20.8/19.6	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 202 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 200 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.7 FINAL - CONTROL 7.0 100% 7.9

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

[signature] 8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: B1020

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24 hrs

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 10 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1321 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1630 AM/PM 8/1/91 END 1630 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	20				
AFTER 48 HRS:	18	17				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	7.0/6.2	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.2/19.0	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ____ EFFLUENT 220 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ____ EFFLUENT 290 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 7.6 FINAL - CONTROL 8.6 100% 8.6

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

[signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00______ OUTFALL: B102059ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 0 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ____%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 13:21 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	19				
AFTER 96 HRS:	20	19				
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.3/4.2	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.0/19.7	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 220 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 290 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.3 FINAL - CONTROL 7.0 100% 8.0

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

[signature] 8/12/91

1/1/91

422491

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00______ OUTFALL: B1020 ST

TYPE TEST: ROUTINE: ✓ 100% Screen. ACCELERATED: ____ TEST SPECIES: Fathead Minnows AGE: 4 days

TEST RESULTS: IWC: _____% CONTROL MORTALITY: 0 % LC50: _____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 100 %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 13:36 AM/PM 8-1-91

TEST TIME & DATE: BEGIN 16:40 AM/PM 8/1/91 END 15:00 AM/PM 8/5/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100 %	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	20	20				
AFTER 48 HRS:	20	20				
AFTER 72 HRS:	20	20				
AFTER 96 HRS:	20	11				
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.0/4.6	7.3/4.2	/	/	/	/
TEMPERATURE °C:	20.8/19.8	21.0/19.7	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT 4 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT 9 RECON/LAB WATER 110

PH: INITIAL - CONTROL 7.9 100% 7.5 FINAL - CONTROL 7.0 100% 7.1

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.H.E. Laboratories ANALYST: Dan Fink Dan Fink

COMMENTS:

8/12/91

1/1/91

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00________ OUTFALL: B1020605T

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24hrs

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: ______%

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: 1336 AM/PM 8/1/91

TEST TIME & DATE: BEGIN 1640 AM/PM 8/1/91 END 1500 AM/PM 8/3/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL(0%)	100%	%	%	%	%
NO. @ START OF TEST:	20	20				
NO. LIVE AFTER 24 HRS:	19	15				
AFTER 48 HRS:	18	5				
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0/6.8	7.1/6.6	/	/	/	/
TEMPERATURE °C:	22.7/19.6	22.6/19.2	/	/	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER ______ EFFLUENT 4 RECON/LAB WATER 131

ALKALINITY, MG/L: RECEIVING WATER ______ EFFLUENT 9 RECON/LAB WATER 110

PH: INITIAL - CONTROL 8.2 100% 7.3 FINAL - CONTROL 8.6 100% 8.5

T. AMMONIA AS N, MG/L: INITIAL - 100% ND FINAL - 100% ND

TOT. RESID. CHLORINE, MG/L: 100% ND SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: T.A.E. Laboratories ANALYST: Michelle Highsmith

COMMENTS:

8/12/91

1/1/91

BIOMONITORING RESULTS FROM EG&G'S ROCKY FLATS PLANT

Submitted to:

Mr. Mark Lewis
S.M. Stoller Corporation
5700 Flatirons Parkway
Boulder, Colorado 80301

Submitted by:

T.H.E. Laboratories, Inc.
325 Interlocken Parkway
Suite 205
Broomfield, Colorado 80021
(303) 438-0970

November 13, 1991

ACUTE TOXICITY TEST SUMMARY

Test: 48-hour static renewal using *Ceriodaphnia* sp. and 96-hour static renewal using fathead minnows (*Pimephales promelas*).

Client: EG&G, Rocky Flats Plant

Test Procedure Followed: Peltier and Weber (1985)

Sample Description:

BIO2132ST	Lindsay Pond
BIO2133ST	C-1
BIO2134ST	C-2
BIO2135ST	SE
BIO2136ST	B-5
BIO2137ST	B-4
BIO2138ST	B-3
BIO2139ST	B-2
BIO2140ST	B-1

Dates of Sample Collection: October 24, 1991

Date of Sample Receipt: October 24, 1991

Dilution Water: Reconstituted water

Test Organism Source: *Ceriodaphnia* - T.H.E. Laboratories
fathead minnows - T.H.E. Laboratories

Reference Toxicant: Sodium Dodecyl Sulfate

ABSTRACT OF RESULTS

Test Concentrations: Control, 100%

Number of organisms in each concentration: 20

Replicates at each concentration: 4

	Ceriodaphnia	Fathead minnows
Test vessel size:	30 ml	260 ml
Exposure volume:	15 ml	200 ml
No. Survivors:		
BIO2132ST	19	19
BIO2133ST	20	20
BIO2134ST	19	20
BIO2135ST	19	20
BIO2136ST	13	10
BIO2137ST	15	6
BIO2138ST	18	10
BIO2139ST	20	19
BIO2140ST	19	20
Temperature range during test (°C):		
BIO2132ST	19.1-21.4	19.0-21.1
BIO2133ST	19.1-21.0	19.0-21.1
BIO2134ST	19.3-21.3	19.0-21.2
BIO2135ST	19.3-20.8	19.0-20.8
BIO2136ST	19.4-21.2	19.0-21.0
BIO2137ST	19.5-21.7	19.0-21.2
BIO2138ST	19.4-22.3	19.8-21.0
BIO2139ST	19.4-21.4	19.5-21.2
BIO2140ST	19.3-21.2	19.8-21.0
Dissolved oxygen range (ml/l):		
BIO2132ST	6.5-7.5	5.4-7.8
BIO2133ST	6.9-7.5	5.6-7.8
BIO2134ST	7.0-7.6	5.5-7.8
BIO2135ST	7.2-7.7	5.5-7.6
BIO2136ST	7.4-7.9	5.5-8.2
BIO2137ST	6.6-7.5	5.1-7.2
BIO2138ST	6.9-7.5	5.4-7.0
BIO2139ST	7.3-7.8	5.4-8.0
BIO2140ST	7.4-8.0	5.8-7.4

	Control	100% Effluent
pH range during test:		
BIO2132ST	7.6-8.4	7.7-8.1
BIO2133ST	7.6-8.5	8.0-8.4
BIO2134ST	7.7-8.6	8.2-8.5
BIO2135ST	8.3-8.6	8.5-8.7
BIO2136ST	8.1-8.5	8.3-8.5
BIO2137ST	7.6-8.3	7.8-8.3
BIO2138ST	7.4-8.3	7.6-8.2
BIO2139ST	8.2-8.5	8.4-8.6
BIO2140ST	8.4-8.6	8.5-8.8

	Control	**100% Effluent**
Alkalinity (mg/l as $CaCO_3$)		
BIO2132ST	90	96
BIO2133ST	90	165
BIO2134ST	90	191
BIO2135ST	90	219
BIO2136ST	90	109
BIO2137ST	90	102
BIO2138ST	90	103
BIO2139ST	90	206
BIO2140ST	90	167
Hardness (mg/l as $CaCO_3$)		
BIO2132ST	135	92
BIO2133ST	135	170
BIO2134ST	135	173
BIO2135ST	135	181
BIO2136ST	135	152
BIO2137ST	135	89
BIO2138ST	135	82
BIO2139ST	135	212
BIO2140ST	135	157
Total ammonia in sample (mg/l)		
BIO2132ST	ND	ND
BIO2133ST	ND	ND
BIO2134ST	ND	ND
BIO2135ST	ND	ND
BIO2136ST	ND	11.4
BIO2137ST	ND	24.7
BIO2138ST	ND	30.5
BIO2139ST	ND	ND
BIO2140ST	ND	ND

Total chlorine (mg/l)		
BIO2132ST	ND	ND
BIO2133ST	ND	ND
BIO2134ST	ND	ND
BIO2135ST	ND	ND
BIO2136ST	ND	ND
BIO2137ST	ND	ND
BIO2138ST	ND	ND
BIO2139ST	ND	ND
BIO2140ST	ND	ND

INTRODUCTION

EG&G's Rocky Flats Plant performs whole effluent toxicity tests on various surface waters on the plant property. The purpose of this testing is to monitor water quality of the surface waters on the plant property. To accomplish this goal, a series of samples were collected during October, 1991 and used in acute screening biomonitoring exposures.

The biomonitoring tests used *Ceriodaphnia* sp., an invertebrate, and fathead minnows (*Pimephales promelas*). Biomonitoring procedures used for testing followed the protocols outlined in Peltier and Weber (1985). These test procedures are consistent with the Colorado Water Quality Control Division and Environmental Protection Agency Region VIII guidelines for biomonitoring. The results of the biomonitoring tests are presented in the following sections.

MATERIALS AND METHODS

Grab samples were collected in one gallon plastic containers on October 24 at nine stations. Sampling times and locations are summarized in Table 1. All samples were delivered to T.H.E.'s lab in ice chests where they were refrigerated at 4°C until testing. Chain of custody forms showing collection and lab arrival times for each sampling period are provided in Appendix 1.

Prior to testing, the samples were analyzed for hardness, alkalinity, conductivity, ammonia, pH, and dissolved oxygen. Hardness and alkalinity were determined titrimetrically. Ammonia was also measured with an Orion ion selective electrode. Methods followed those described in APHA (1985). Conductivity, dissolved oxygen, and pH were measured with probes after calibration of instruments.

The full strength effluent sample and a control were used for testing the *Ceriodaphnia* sp. and fathead minnows. Reconstituted water was used as the source of dilution water and a control.

Less than 24 hour old *Ceriodaphnia* and four day old minnows were used. The organisms came from T.H.E.'s in-house cultures. These animals are tested monthly in a reference toxicant test using sodium dodecyl sulfate.

Ceriodaphnia were exposed to the various effluent concentrations for 48 hours. Fathead minnow tests were run for 96 hours. The exposure medium was replaced after each 24 hour period and the number of surviving organisms counted and recorded. Routine measurements of pH, temperature, and dissolved oxygen were made for each 24 hour period prior to and after water was changed. Tests were run in an environmental chamber programmed for a

Table 1. Summary of sample collection times and station designations.

STATION	DATE OF COLLECTION	STATION ACRONYM
BIO2132ST	10/24/91	Lindsay Pond
BIO2133ST	10/24/91	C-1
BIO2134ST	10/24/91	C-2
BIO2135ST	10/24/91	SE
BIO2136ST	10/24/91	B-5
BIO2137ST	10/24/91	B-4
BIO2138ST	10/24/91	B-5
BIO2139ST	10/24/91	B-2
BIO2140ST	10/24/91	B-1

16 hr light/8 hr dark cycle and maintained at 20°C.

RESULTS

The results of the biomonitoring tests are summarized in Table 2 and presented in detail on the lab data sheets in Appendix 2. In the *Ceriodaphnia* test, two of the samples showed a low level of toxicity. These samples corresponded to the B-4 and B-5 pond samples. In the B-4 pond, 15 of the animals survived with 13 survivors being measured in the B-5 pond. This compared to 18-20 survivors in the other pond samples and the control.

In the fathead minnow test, three of the pond samples produced a toxic effect. These were the B-3, B-4, and B-5 ponds with 10, 6, and 9 survivors respectively. This compared to 19-20 survivors in the remaining ponds and the controls.

DISCUSSION

The B-4 and B-5 ponds have previously shown toxicity to the ceriodaphs and fathead minnows. The B-3 pond has not previously been tested. Of the other ponds, only the C-2 waters have previously been tested. This sample does not usually show a toxic effect.

Earlier testing in the "B" series ponds have suggested that ammonia may be the cause of the observed mortalities. In the present samples, ammonia was measured at 30.5, 24.7, and 11.4 mg/l in the B-3, B-4, and B-5 ponds, respectively. None of the other ponds had a detectable level of ammonia. The measured toxicity is consistent with expected toxicity levels from unionized ammonia given the comparative pH and ammonia levels in each of the ponds.

REFERENCES

APHA/AWWA/WPCF. 1985. Standard methods for the examination of water and wastewater. 16th Edition. American Public Health Association. 1268 pp.

Peltier, W.H. and C.I. Weber. 1985. Methods for measuring the acute toxicity of effluents to freshwater and marine organisms (third edition). Environmental Protection Agency Report No. EPA 600/4-85/013. 216 pp.

Table 2. Summary of surviving organisms at each sampling station collected on October 24, 1991. Each test began with 20 animals.

STATION	*CERIODAPHNIA*	FATHEAD MINNOWS
Control	18	19
Lindsay Pond	19	19
C-1	20	20
C-2	19	20
SE	19	20
B-5	13	10
B-4	15	6
B-3	18	10
B-2	20	19
B-1	19	20

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00______ OUTFALL: Various

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24hrs.

TEST RESULTS: IWC: ______% CONTROL MORTALITY: 10 % LC50: ______%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 2136ST, 2137ST %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: * AM/PM

TEST TIME & DATE: BEGIN 16:00 AM/PM 10/24/91 END 16:00 AM/PM 10/26/91

MEASUREMENTS	CONTROL (0%)	2132ST 100%	2133ST 100%	2134ST 100%	2135ST 100%	2136ST 100%
		DILUTIONS (% EFFLUENT)				
NO. @ START OF TEST:	20	20	20	20	20	20
NO. LIVE AFTER 24 HRS:	20	20	20	19	20	14
AFTER 48 HRS:	18	19	20	19	19	13
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.0/6.3	7.5/6.5	7.5/6.9	7.6/7.0	7.7/7.2	7.9/7.4
TEMPERATURE °C:	21.3/18.9	21.4/19.1	21.0/19.1	21.3/19.3	20.8/19.3	21.2/19.4

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT* RECON/LAB WATER 135

ALKALINITY MG/L: RECEIVING WATER NA EFFLUENT* RECON/LAB WATER 90

PH: INITIAL - CONTROL 7.9 100% * FINAL - CONTROL 8.1 100% *

T. AMMONIA AS N, MG/L: INITIAL - 100% * FINAL - 100% *

TOT. RESID. CHLORINE, MG/L: 100% ND for all SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: THE Laboratories Inc. ANALYST: Karen Christensen, Jason

COMMENTS: Time + Date

				Hardness	Alkalinity
2132ST	11:30 am	10-24-91	2132ST	92	96
2133ST	11:45 am	10-24-91	2133ST	170	165
2134ST	12:00 pm	10-24-91	2134ST	173	191
2135ST	12:45 pm	10-24-91	2135ST	181	219
2136ST	13:30 pm	10-24-91	2136ST	152	109

11/1/91

11/15/91

... initial final pH initial final Total Ammonia 2132ST initial 224 final ND Total Ammonia initial 123 final ND

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 ____ OUTFALL: Various

TYPE TEST: ROUTINE: ✓ ACCELERATED: ____ TEST SPECIES: Ceriodaphnia AGE: <24hrs

TEST RESULTS: IWC: ____% CONTROL MORTALITY: 10 % LC50: ____%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 2136ST, 2137ST %

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: * ____ AM/PM

TEST TIME & DATE: BEGIN 16:00 AM/PM 10/24/91 END 16:00 AM/PM 10/26/91

MEASUREMENTS	CONTROL (0%)	2137ST 100%	2138ST 100%	2139ST 100%	2140ST 100%	%
		DILUTIONS (% EFFLUENT)				
NO. @ START OF TEST:	20	20	20	20	20	
NO. LIVE AFTER 24 HRS:	20	16	19	20	19	
AFTER 48 HRS:	18	15	18	20	19	
AFTER 72 HRS:						
AFTER 96 HRS:						
MAX/MIN VALUES						
DISSOLVED OXYGEN, MG/L:	7.0 / 6.3	7.5 / 6.6	7.5 / 6.9	7.8 / 7.3	8.0 / 7.4	/
TEMPERATURE °C:	21.3 / 18.9	21.7 / 19.5	22.3 / 19.4	21.4 / 19.4	21.2 / 19.3	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 135

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 90

PH: INITIAL - CONTROL 7.9 100% * FINAL - CONTROL 8.1 100% *

T. AMMONIA AS N, MG/L: INITIAL - 100% * FINAL - 100% *

TOT. RESID. CHLORINE, MG/L: 100% ND for all SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: THE Laboratories, Inc. ANALYST: Karen Christensen, Jason T[illegible]

COMMENTS: Time + Date

			Hardness	Alkalinity	pH initial	final
2137ST	13:35pm 10-24-91	2137ST	89	102	7.6	8.3
2138ST	13:45pm 10-24-91	2138ST	82	103	7.4	8.3
2139ST	13:55pm 10-24-91	2139ST	212	206	8.3	8.5
2140ST	14:??pm 10-24-91	2140ST	157	167	8.5	8.5

1/1/91

Ammonia initial final : initial final

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: Various

TYPE TEST: ROUTINE: ___ ACCELERATED: ___ TEST SPECIES: Fathead minnows AGE: 4 days

TEST RESULTS: IWC: ___% CONTROL MORTALITY: 5 % LC50: ___%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 2136ST, 2137ST, 2138ST

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: * AM/PM

TEST TIME & DATE: BEGIN 16:30 AM/PM 10/24/91 END 13:40 AM/PM 10/28/91

MEASUREMENTS	2132ST 100% ~~CONTROL (0%)~~	100 2133ST %	2134ST 100 %	2135ST 100 %	2136ST 100 %	2137ST 100 %
	DILUTIONS (% EFFLUENT)					
NO. @ START OF TEST:	20	20	20	20	20	20
NO. LIVE AFTER 24 HRS:	20	20	20	20	16	20
AFTER 48 HRS:	19	20	20	20	15	7
AFTER 72 HRS:	19	20	20	20	14	7
AFTER 96 HRS:	19	20	20	26	10	6
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.8/5.4	7.8/5.6	7.8/5.5	7.6/5.5	8.2/5.5	7.2/5.1
TEMPERATURE °C:	21.1/19.0	21.1/19.0	21.2/19.0	20.8/19.0	21.0/19.0	21.2/19.0

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 135

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 90

PH: INITIAL - CONTROL 8.6 100% ___ FINAL - CONTROL 8.3 100% ___

T. AMMONIA AS N, MG/L: INITIAL - 100% * FINAL - 100% ___

TOT. RESID. CHLORINE, MG/L: 100% ND for all SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: THE Laboratories Inc. ANALYST: Dan Fink Jason Nelson

COMMENTS:

Time & Date				Hardness	Alkalinity	pH	initial	final
2132ST	11:30am	10-24-91	2132ST	92	96	2132ST	7.8	8.4 7.9
2133ST	11:45am	10-24-91	2133ST	170	165	2133ST	8.0	8.2
2134ST	12:00pm	10-24-91	2134ST	173	191	2134ST	8.2	8.4
2135ST	12:45pm	10-24-91	2135ST	181	219	2135ST	8.6	8.5
2136ST	13:30pm	10-24-91	2136ST	152	109	2136ST	8.8	9.9
2137ST	13:35pm	10-24-91	2137ST	89	102	2137ST	7.8	8.2

1/1/91

Ammonia initial final initial final

2137ST .123 ND

COLORADO - CDPS WET TEST REPORT FORM - ACUTE

PERMITTEE: Rocky Flats CDPS NO. CO-00 OUTFALL: Various

TYPE TEST: ROUTINE: ✓ ACCELERATED: ___ TEST SPECIES: Fathead minnows AGE: 4 days

TEST RESULTS: IWC: ___% CONTROL MORTALITY: 5 % LC50: ___%

50% MORTALITY LIMIT: PASS/FAIL CONC WITH STAT. SIGNIFICANT MORTALITY: 2136ST, 2137ST, 2138ST

SAMPLE TYPE: GRAB/COMPOSITE TIME & DATE: * AM/PM

TEST TIME & DATE: BEGIN 17:00 AM/PM 10/24/91 END 14:00 AM/PM 10/28/91

DILUTIONS (% EFFLUENT)

MEASUREMENTS	CONTROL (0%)	2138ST 100 %	2139ST 100 %	2140ST 100 %	%	%
NO. @ START OF TEST:	20	20	20	20		
NO. LIVE AFTER 24 HRS:	20	16	20	20		
AFTER 48 HRS:	20	13	19	20		
AFTER 72 HRS:	20	10	19	20		
AFTER 96 HRS:	19	10	19	20		
MAX/MIN VALUES DISSOLVED OXYGEN, MG/L:	7.0/5.8	7.0/5.4	8.0/5.4	7.4/5.8	/	/
TEMPERATURE °C:	20.0/19.6	21.0/19.8	21.2/19.5	21.0/19.8	/	/

RECEIVING WATER USED FOR DILUTION? YES/NO SAMPLE AERATED? YES/NO

HARDNESS, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 135

ALKALINITY, MG/L: RECEIVING WATER NA EFFLUENT * RECON/LAB WATER 90

PH: INITIAL - CONTROL 8.6 100% * FINAL - CONTROL 8.3 100% *

T. AMMONIA AS N, MG/L: INITIAL - 100% * FINAL - 100% *

TOT. RESID. CHLORINE, MG/L: 100% ND for all SAMPLE DECHLORINATED BEFORE TEST? YES/NO

LABORATORY: THE Laboratories, Inc. ANALYST: Dan Fink, Jason Nelson

COMMENTS: Time + Date

				Hardness	Alkalinity		pH initial	final
2138ST	13:45	10-24-91	2138ST	82	103	2138ST	7.6	8.2
2139ST	13:55	10-24-91	2139ST	212	206	2139ST	8.6	8.4
2140ST	14:00	10-24-91	2140ST	157	167	2140ST	8.8	8.

Ammonia	initial	final
2138ST	3.05	29.3
2139ST	~~.369~~ .359	ND
2140ST	.278	ND

[signature] 11/15/91

1/1/91

ATTACHMENT E-5

PLANT AND ANIMAL SPECIES REFERENCED IN THE OU1 ENVIRONMENTAL EVALUATION REPORT

List of Mammals Referenced in OU1 Environmental Evaluation Report, Rocky Plats Plant, Jefferson County, Colorado

Scientific Name	Common Name
<u>Leporidae</u>	
Lepus californicus	Black-tailed Jackrabbit
Lepus townsendii	White-tailed Jackrabbit
Sylvilagus audubonii	Desert Cottontail
<u>Sciuridae</u>	
Cynomys ludovicianus	Black-tailed Prairie Dog
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel
<u>Geomyidae</u>	
Thomomys talpoides	Northern Pocket Gopher
<u>Heteromyidae</u>	
Perognathus flavus	Silky Pocket Mouse
Perognathus hispidus	Hispid Pocket Mouse
<u>Cricetidae</u>	
Microtus ochrogaster	Prairie Vole
Microtus pennsylvanicus	Meadow Vole
Neotoma mexicana	Mexican Woodrat
Ondatra zibethicus	Muskrat
Peromyscus maniculatus	Deer Mouse
Reithrodontomys megalotis	Western Harvest Mouse
Reithrodontomys montanus	Plains Harvest Mouse
<u>Muridae</u>	
Mus musculus	House Mouse
<u>Zapodidae</u>	
Zapus hudsonius ssp. *preblei*	Preble's Meadow Jumping Mouse
Zapus princeps	Western Jumping Mouse
<u>Canidae</u>	
Canis latrans	Coyote
Vulpes velox	Swift Fox
Vulpes vulpes	Red Fox
Urocyon cinereoargenteus	Gray Fox
<u>Procyonidae</u>	
Procyon lotor	Raccoon

<u>Mustelidae</u>	
Mephitis mephitis	Striped Skunk
Mustela frenata	Long-tailed Weasel
Mustela nigripes	Black-footed Ferret
Taxidea taxus	Badger
<u>Felidae</u>	
Lynx rufus	Bobcat
<u>Cervidae</u>	
Odocoileus hemionus	Mule Deer
Odocoileus virginianus	White-tailed Deer

List of Birds Referenced in OU1 Environmental Evaluation Report, Rocky Plats Plant, Jefferson County, Colorado

Scientific Name	Common Name
Phalacrocoracidae	
Phalacrocorax auritus	Double-crested Cormorant
Ardeidae	
Ardea herodias	Great Blue Heron
Nycticorax nycticorax	Black-crowned Night-Heron
Threshkiornithidae	
Plegadis chihi	White-faced Ibis
Anatidae	
Anas crecca	Green-winged Teal
Anas discors	Blue-winged Teal
Anas platyrhynchos	Mallard
Anas strepera	Gadwall
Rallidae	
Porzana carolina	Sora
Charadriidae	
Charadrius montanus	Mountain Plover
Charadrius vociferus	Killdeer
Scolopacidae	
Actitis macularia	Spotted Sandpiper
Gallinago gallinago	Common Snipe
Numenius americanus	Long-billed Curlew
Accipitridae	
Aquila chrysaetos	Golden Eagle
Buteo jamaicensis	Red-tailed Hawk
Buteo lagopus	Rough-legged Hawk
Buteo regalis	Ferruginous Hawk
Buteo swainsoni	Swainson's Hawk
Haliaeetus leucocephalus	Bald Eagle
Falconidae	
Falco mexicanus	Prairie Falcon
Falco peregrinus	Peregrine Falcon
Falco sparverius	American Kestrel

Strigidae

Asio flammeus	Short-eared Owl
Asio otus	Long-eared Owl
Bubo virginianus	Great horned Owl

Tyrannidae

Tyrannus tyrannus	Eastern Kingbird
Tyrannus verticalis	Western Kingbird

Corvidae

Pica pica	Black-billed Magpie

Alaudidae

Eremophila alpestris	Horned Lark

Muscicapidae

Turdus migratorius	American Robin

Vireonidae

Vireo gilvus	Warbling Vireo

Parulidae

Dendroica petechia	Yellow Warbler
Opornis tolmiei	MacGillivray's Warbler
Geothlypis trichas	Common Yellowthroat
Icteria virens	Yellow-breasted Chat

Emberizidae

Agelaius phoeniceus	Red-winged Blackbird
Ammodramus savannarum	Grasshopper Sparrow
Guiraca caerule	Blue Grosbeak
Icterus galbula	Northern Oriole
Junco hyemalis	Dark-eyed Junco
Melospiza melodia	Song Sparrow
Passerina cyanea	Indigo Bunting
Passerina amoena	Lazuli Bunting
Pheucticus melanocephalus	Black-headed Grosbeak
Pipilo erythrophthalmus	Rufous-sided Towhee
Pipilo chlorurus	Green-tailed Towhee
Pooecetes gramineus	Vesper Sparrow
Sturnella neglecta	Western Meadowlark

Fringillidae

Carduelis pinus	Pine Siskiu
Carduelis psaltria	Lesser Goldfinch
Carduelis tristis	American Goldfinch

List of Amphibians and Reptiles Referenced in OU1 Environmental Evaluation Report, Rocky Plats Plant, Jefferson County, Colorado

Scientific Name	Common Name
Amphibia	
Ambystomatidae	
Ambystoma tigrinum	Tiger Salamander
Ranidae	
Rana pipiens	Leopard Frog
Bufonidae	
Bufo woodhousii	Woodhouse's Toad
Hylidae	
Pseudacris triseriata	Northern Chorus Frog
Reptilia	
Emydidae	
Chrysemys picta	Western Painted Turtle
Colubridae	
Coluber constrictor	Yellow-bellied Racer
Pituophis melanoleucus	Bullsnake
Thamnophis elegans	Western Terrestrial Garter Snake
Viperidae	
Crotalus viridis	Prairie Rattlesnake

List of Fish Referenced in OU1 Environmental Evaluation Report, Rocky Plats Plant, Jefferson County, Colorado

Scientific Name	Common Name
Cyprinidae	
Campostoma anomalum	Stoneroller
Carassius auratus	Goldfish
Ctenopharyngodon idellus	Grass Carp
Notemigonus crysoleucas	Golden Shiner
Pimephales promelas	Fathead Minnow
Semotilus atromaculatus	Creek Chub
Catostomidae	
Catostomus commersoni	White Sucker
Centrarchidae	
Lepomis cyanellus	Green Sunfish
Micropterus salmoides	Largemouth Bass

List of Plants Referenced in OU1 Environmental Evaluation Report
Rocky Flatas Plant, Jefferson County, Colorado

Scientific Name	Common Name
Agavaceae	
Yucca glauca	Yucca
Anacardiaceae	
Rhus aromatica var. *trilobata*	Skunkbrush Sumac
Apiaceae	
Lomatium orientale	Wild Parsely
Asclepiadaceae	
Asclepias incarnata	Swamp Milkweed
Asclepias speciosa	Showy Milkweed
Asteraceae	
Achillea millefolium ssp. *lanulosa*	Yarrow
Ambrosia psilostachya	Western Ragweed
Artemisia campestris	Common Sage
Artemisia dracunculus	Wild Tarragon
Artemisia frigida	Fringed Sagebrush
Artemisia ludoviciana	Louisiana Sage
Aster falcatus	Prairie Aster
Aster porteri	White Aster
Bidens cernua	Nodding Beggarticks
Carduus nutans	Musk Thistle
Centaurea diffusa	Diffuse Knapweed
Centaurea repens	Russian Knapweed
Chrysopsis [=Heterotheca] villosa	Hairy Golden-aster
Chrysothamnus nauseosus	Rubber Rabbitbrush
Cirsium arvense	Canada Thistle
Cirsium undulatum	Wavyleaf Thistle
Conyza canadensis	Horseweed
Dyssodia papposa	Field Marigold
Erigeron divergens	Spreading Fleabane
Erigeron flagellaris	Trailing Fleabane
Grindelia squarrosa	Curly-cup Gumweed
Gutierrezia sarothrae	Broom Snakeweed
Helianthus annuus	Common Sunflower
Helianthus pumilus	Low Sunflower
Lactuca serriola	Prickly Lettuce
Liatris punctata	Blazing Star
Ratibida columnifera	Prairie Coneflower
Solidago missouriensis	Prairie Goldenrod

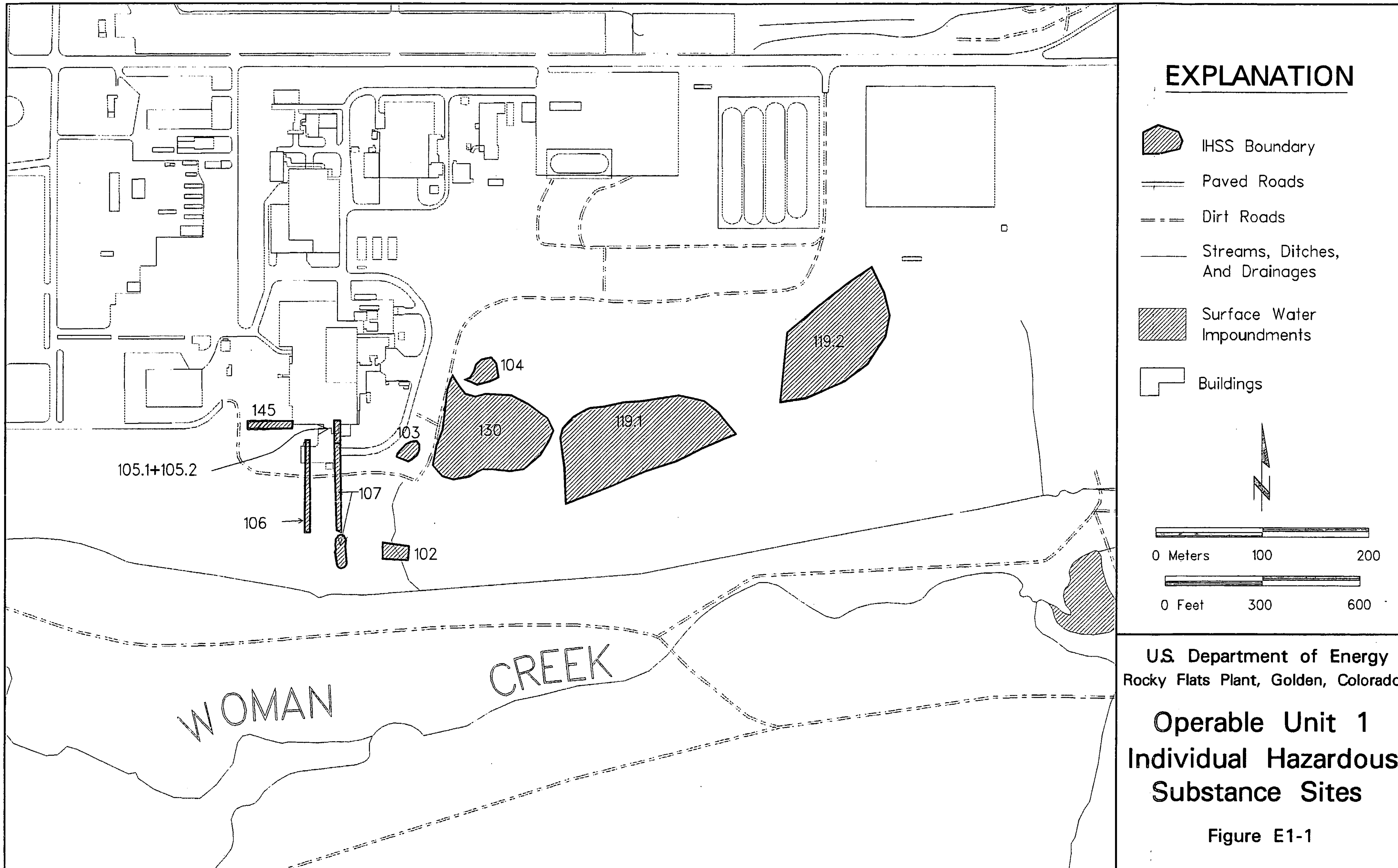
Solidago mollis	Soft Goldenrod
Solidago nemoralis	Gray Goldenrod
Sonchus arvensis	Sow-thistle
Taraxacum officinale	Common Dandelion
Tragopogon dubius	Yellow Salsify
Boraginaceae	
Cynoglossum officinale	Hound's Tongue
Brassicaceae	
Alyssum minus	Alyssum
Barbarea orthoceras	Winter Cress
Erysimum asperum	Western Wallflower
Cactaceae	
Echinocereus viridiflorus	Hedgehog Cactus
Mammilaria missouriensis	Nipple Cactus
Opuntia fragilis	Brittle Cactus
Opuntia humifusa (=compressa)	Plains Prickly Pear
Opuntia polyacantha	Starvation Cactus
Callitrichaceae	
Lobelia siphilitica	Great Lobelia
Cannabaceae	
Humulus lupulus	Common Hops
Caprifoliaceae	
Symphoricarpos occidentalis	Western Snowberry
Caryophyllaceae	
Arenaria fendleri	Fendler Sandwort
Paronychia jamesii	Nailwort
Vaccaria pyramidata	Cow Cockle
Chenopodiaceae	
Chenopodium leptophyllum	Narrowleaf Goosefoot
Salsola iberica	Russian-thistle
Clusiaceae	
Hypericum perforatum	Common St. John's-wort
Convolvulaceae	
Convolvulus arvensis	Field Bindweed
Cyperaceae	
Carex eleocharis (=stenophylla)	Narrowleaf Sedge
Carex filifolia	Threadleaf Sedge

Carex lanuginosa	Woolly Sedge
Carex nebraskensis	Nebraska Sedge
Carex praegracilis	Cluster-field Sedge
Eleocharis macrostachya	Spike Rush
Scirpus pallidus	Dark-green Bulrush
Equisetaceae	
Equisetum crvense	Field Horsetail
Elaeagnaceae	
Elaeagnus angustifolia	Russian-olive
Euphorbiaceae	
Euphorbia [=Chamaesyce] serpyllifolia	Thyme-leaved Spurge
Fabaceae	
Amorpha fruticosa	Leadplant
Dalea purpurea [=Petalostemon purpureum]	Purple Prairie-clover
Glycyrrhiza lepidota	Wild Licorice
Medicago lupulina	Black Medic
Melilotus alba	White Sweetclover
Melilotus officinalis	Yellow Sweetclover
Oxytropis lambertii	Purple Locoweed
Thermopsis rhombifolia var. *divaricarpa*	Golden Banner
Geraniaceae	
Erodium cicutarium	Crane's-bill
Geranium caespitosum (=fremontii)	Wild Geranium
Grossulariaceae	
Ribes odoratum (=aureum)	Golden Currant
Hydrophyllaceae	
Phacelia heterophylla	Scorpionweed
Juncaceae	
Juncus balticus	Baltic Rush
Juncus dudleyi	Dudley Rush
Limiaceae	
Lycopus americanus	Water-horehound
Mentha arvensis	Field Mint
Nepeta cataria	Catnip
Liliaceae	
Allium textile	Wild White Onion

<u>Lythraceae</u>	
Rotala remosior	Toothcup
<u>Malvaceae</u>	
Sphaeralcea coccinea	Scarlet Globemallow
<u>Onagraceae</u>	
Oenothera flava	Yellow Evening-primrose
Oenothera strigosa	Common Evening-primrose
Gaura neomexicana ssp. *coloradensis*	Colorado Butterfly Plant
<u>Orchidaceae</u>	
Spiranthes diluvialis	Ute Ladies Tresses
<u>Oxalidaceae</u>	
Oxalis dillenii	Wood-sorrel
<u>Pinaceae</u>	
Pinus ponderosa	Ponderosa Pine
<u>Plantaginace</u>	
Plantago major	Common Plantain
<u>Poaceae</u>	
Agropyron cristatum	Crested Wheatgrass
Agropyron intermedium	Intermediate Wheatgrass
Agropyron repens	Quackgrass
Agropyron smithii	Western Wheatgrass
Agrostis hyemalis	Ticklegrass
Agrostis stolonifera	Redtop
Andropogon gerardii	Big Bluestem
Andropogon scoparius	Little Bluestem
Aristida basiramea	Forktip Three-awn
Aristida purpurea	Red Three-awn
Bouteloua curtipendula	Side-oats Grama
Bouteloua gracilis	Blue Grama
Bromus [=Bromopsis] inermis	Smooth Brome
Bromus japonicus	Japanese Brome
Bromus [=Bromopsis] porteri	Nodding Brome
Bromus tectorum	Cheatgrass
Buchloe dactyloides	Buffalo-grass
Calamagrostis canadensis	Canadian Reedgrass
Calamovilfa longifolia	Prairie Sandreed
Dactylis glomerata	Orchardgrass
Elymus canadensis	Canada Wild-rye
Glyceria striata	Fowl Mannagrass
Hordeum jubatum	Foxtail Barley
Koeleria pyramidata	Prairie Junegrass

Muhlenbergia montana	Mountain Muhly
Muhlenbergia racemosa	Marsh Muhly
Muhlenbergia torreyi	Ring Muhly
Muhlenbergia wrightii	Spike Muhly
Panicum capillare	Witchgrass
Panicum virgatum	Switchgrass
Phleum pratense	Common Timothy
Poa compressa	Canada Bluegrass
Poa pratensis	Kentucky Bluegrass
Polypogon monspeliensis	Rabbitfoot Grass
Schedonnardus paniculatus	Tumblegrass
Setaria viridis	Green Foxtail
Sitanion hystrix	Bottlebrush Squirreltail
Sorghastrum nutans	Yellow Indian-grass
Spartina pectinata	Prairie Cordgrass
Sporobolus cryptandrus	Spike Dropseed
Sporobolus heterolepis	Prairie Dropseed
Stipa comata	Needle-and-thread
Stipa robusta	Sleepy Grass
Stipa viridula	Green Needlegrass
<u>Polemoniaceae</u>	
Collomia linearis	Collomia
<u>Polygonaceae</u>	
Eriogonum alatam	Winged Eriogonum
Polygonum amphibium [=Persicaria coccineum]	Scarlet Smartweed
Polygonum [=Fallopia] convolvulus	Wild Buckwheat
Rumex obtusifolius	Bitter Dock
<u>Ranunculaceae</u>	
Ranunculus macounii	Macoun's Buttercup
<u>Rosaceae</u>	
Crataegus erythropoda	Hawthorn
Physocarpus monogynus	Mountain Ninebark
Potentilla gracilis	Soft Cinquefoil
Potentilla hippiana	Woolly Cinquefoil
Prunus americana	Wild Plum
Prunus virginiana	Chokecherry
Rosa acicularis	Prickly Rose
<u>Rubiaceae</u>	
Galium aparine	Catchweed Bedstraw
<u>Salicaceae</u>	
Populus alba	White Poplar
Populus angustifolia	Narrowleaf Cottonwood

Populus deltoides var. *occidentalis*	Plains Cottonwood
Salix amygdaloides	Peachleaf Willow
Salix exigua	Sandbar Willow
Scrophulariaceae	
Verbascum blattaria	Moth Mullein
Verbascum thapsus	Great Mullein
Veronica americana	Brooklime
Veronica anagallis-aquatica	Water Speedwell
Typhaceae	
Typha angustifolia	Narrowleaf Cattail
Typha latifolia	Broadleaf Cattail
Ulmaceae	
Ulmus pumila	Siberian Elm
Verbenaceae	
Lippia [=Phyla] cuneifolia	Fog-fruit
Verbena bracteata	Bracted Vervain
Verbena hastata	Blue Vervain
Violaceae	
Viola nephrophylla	Blue Violet

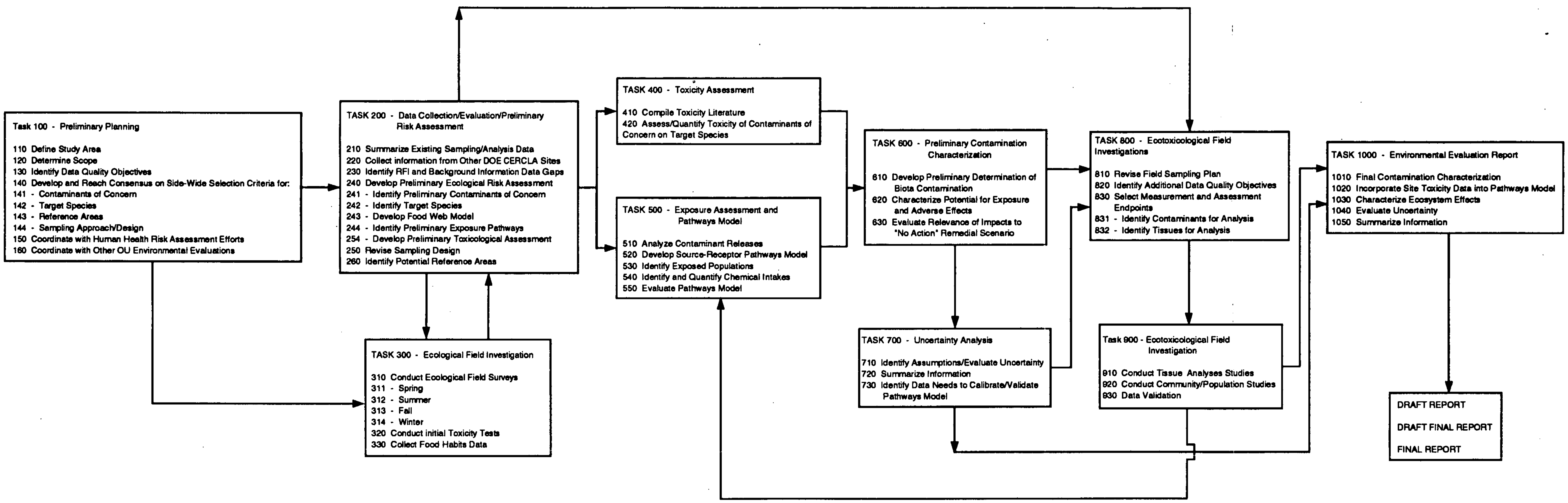


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Operable Unit 1 Individual Hazardous Substance Sites

Figure E1-1

08/04/93 ou1ihss.map



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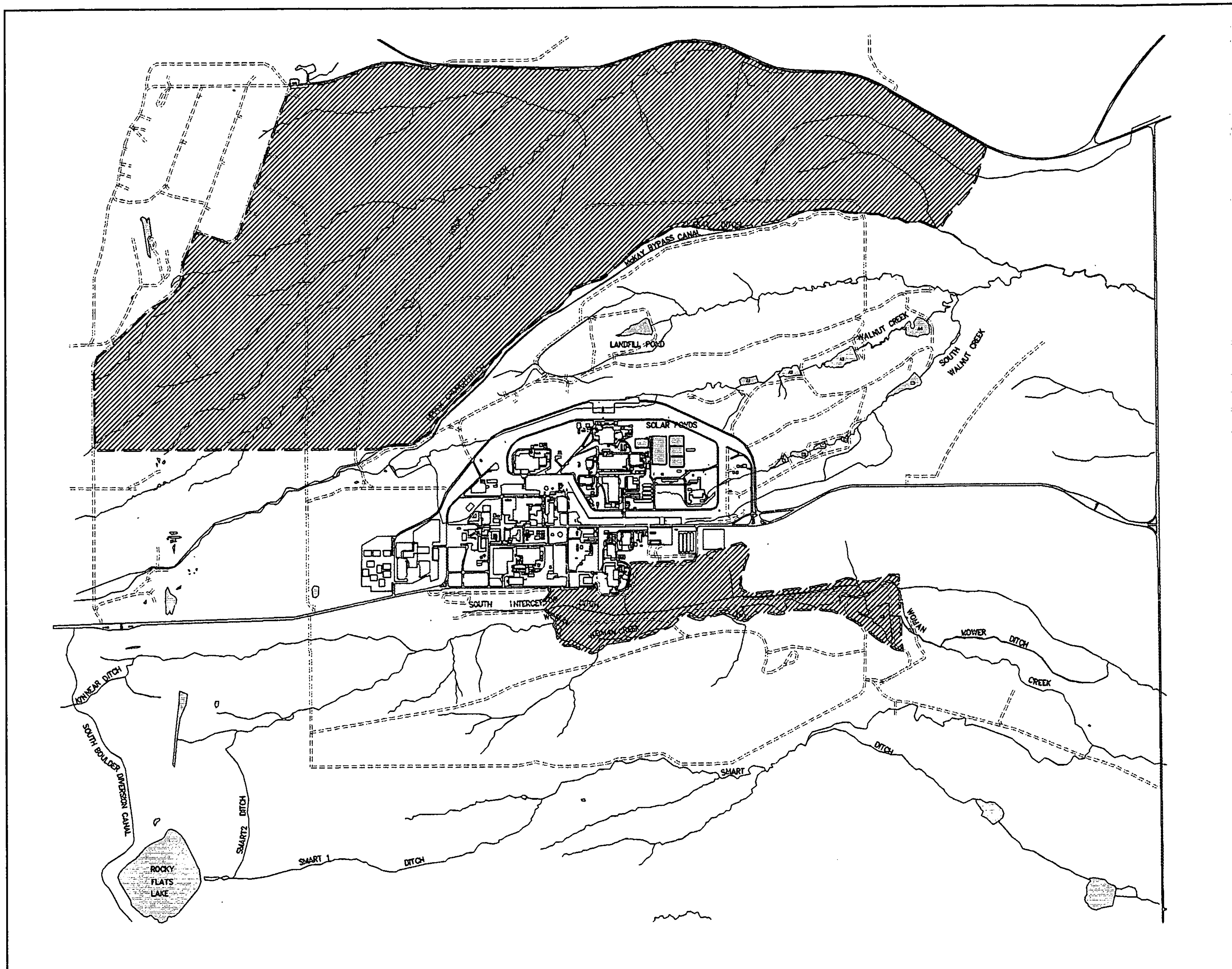
881 HILLSIDE AREA
OPERABLE UNIT 1
PHASE III RFI/RI REPORT

FLOW DIAGRAM:
INTERRELATIONSHIPS BETWEEN TASKS
IN ENVIRONMENTAL EVALUATION

Figure E1-2 May 1994

M:\ES\OU1 flow diagram.mdw\5/17/94



EXPLANATION

Reference Area Boundary

Study Area Boundary

Paved Roads

Streams, Ditches, And Drainages

Surface Water Impoundments

0 Meters 700 1400

0 Feet 2000 4000

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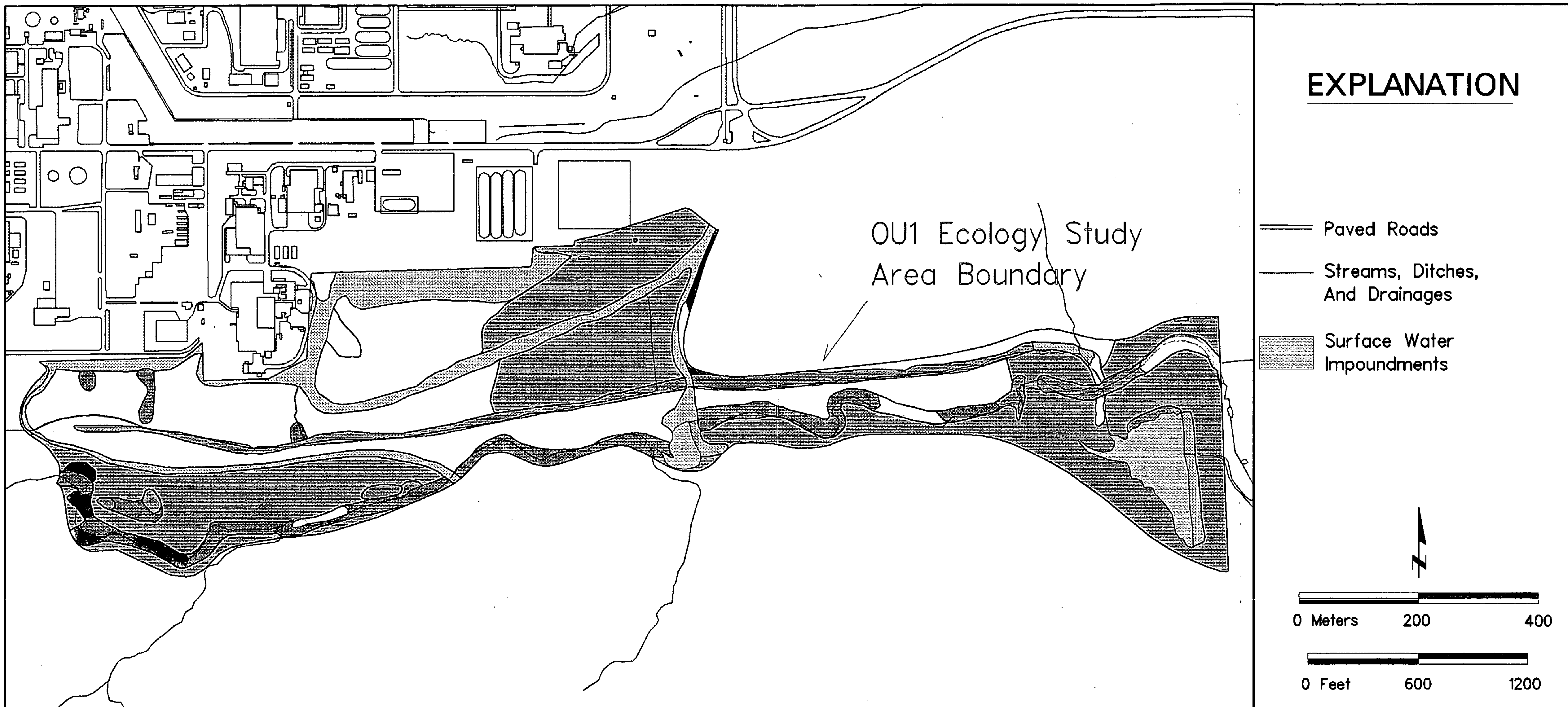
OU1 Ecology Study Area and Terrestrial Reference Area

Figure E2-1

05/12/94 TERREREF2.MAP



Vegetation Key

- Short Marsh (Rushes)
- Tall Marsh (Cattails)
- Riparian Woodland
- Bottomland Shrub (Leadplant)
- Short Upland Shrub (Snowberry)
- Short Grassland
- Mesic Mixed Grassland
- Xeric Mixed Grassland
- Reclaimed Grassland
- Disturbed Area/Barren Land

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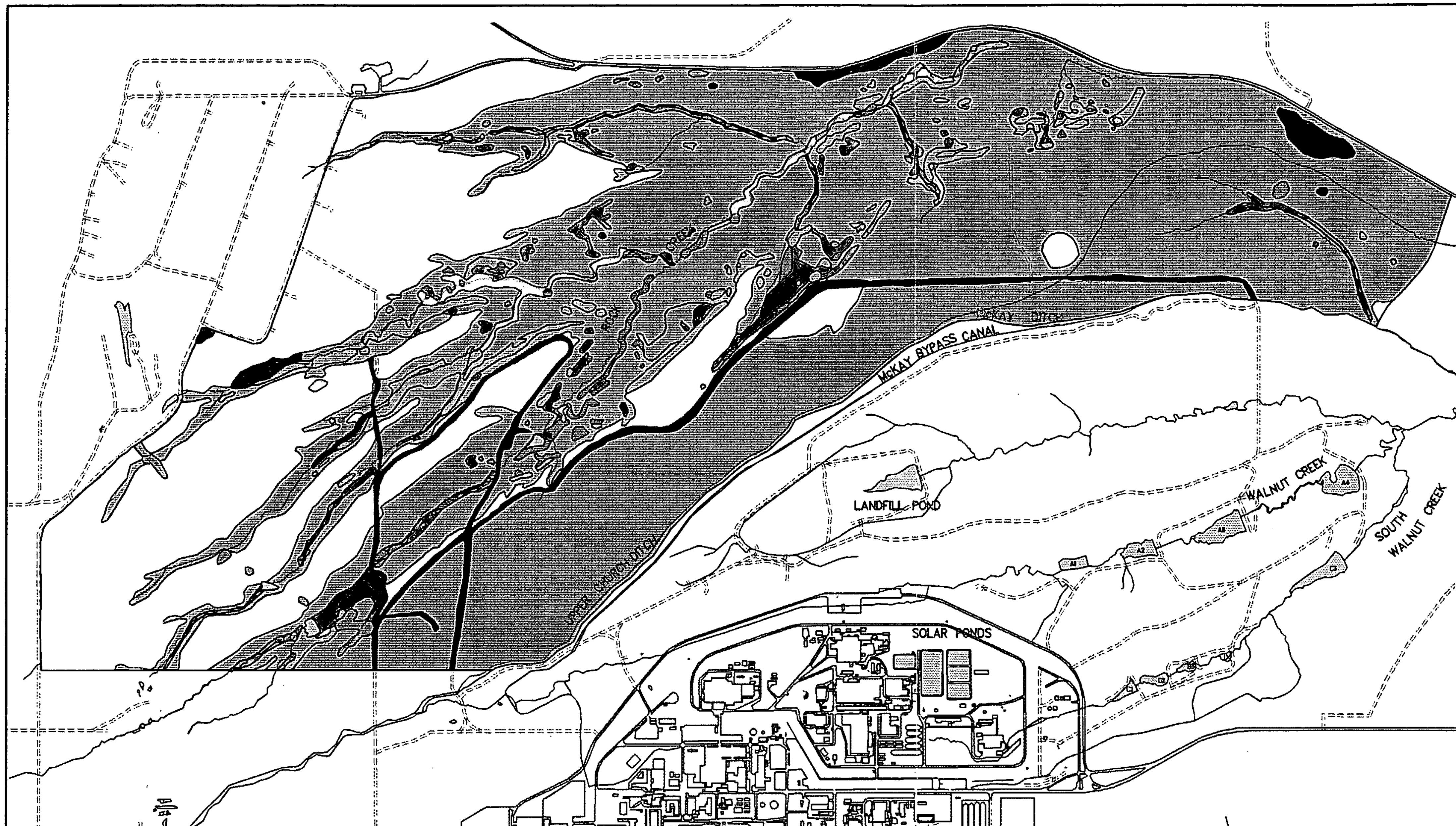
Vegetation Types within OU1 Study Area

Figure E2-2

05/12/94 OU1VEG2.MAP



EXPLANATION

Paved Roads

Streams, Ditches, And Drainages

Surface Water Impoundments

0 Meters 500 1000

0 Feet 1500 3000

Vegetation Key

- Wet Meadow
- Short Marsh (Rushes)
- Tall Marsh (Cattails)
- Riparian Woodland
- Ponderosa Pine
- Bottomland Shrub (Leadplant)
- Short Upland Shrub (Snowberry)
- Tall Upland Shrub
- Short Grassland
- Mixed Grassland Complex
- Mesic Mixed Grassland
- Xeric Mixed Grassland
- Reclaimed Grassland
- Disturbed Area – Annual Grass/Forb
- Disturbed Area – Barren Land

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Vegetation Types within Terrestrial Reference Area

Figure E2-3

05/12/94 REFVEG2.MAP

Table E6-8

Exposure Estimations for Mule Deer[a]

COC	Food ingestion rate (FIR) kg/day	Concentration in food(C_f)[b] mean	sd	Assimilation a unitless	Water ingestion rate (WIR) L/day[c]	Concentration in water (C_w)[d] mean	sd	Soil ingestion rate (SIR) kg/day	Concentration in soil (C_s)[b] mean	sd	Assimilation a unitless	Site use factor (SU) unitless	Body weight kg	Uptake (mg/kg-day) mean	sd
Selenium	1.5	0.73	0.99	1	3.6	1.3	0.36	0.016	0.25	0.17	1	0.52	70	0.043	0.017
Plutonium-239,-240	1.5	0.015	0.028	0.001	3.6	0.0071	0.0052	0.016	2.4	3.5	0.001	0.52	70	4.7E-07	4.1E-07
Americium-241	1.5	0.0065	0.017	0.001	3.6	0.021	0.038	0.016	0.41	0.51	0.001	0.52	70	6.2E-07	1.1E-06
Uranium (total)	1.5	0.12	0.30	0.001	3.6	5.8	7.5	0.016	2.4	0.53	0.001	0.52	70	1.6E-04	2.0E-04
Benzo(a)pyrene	1.5	0.26	0.14	1	3.6	ND	---	0.016	0.26	0.14	0.9	0.52	70	0.0027	0.0014
Total PCBs	1.5	0.0031	0.0027	1	3.6	ND	---	0.016	0.16	0.17	0.9	0.52	70	4.9E-05	3.2E-05

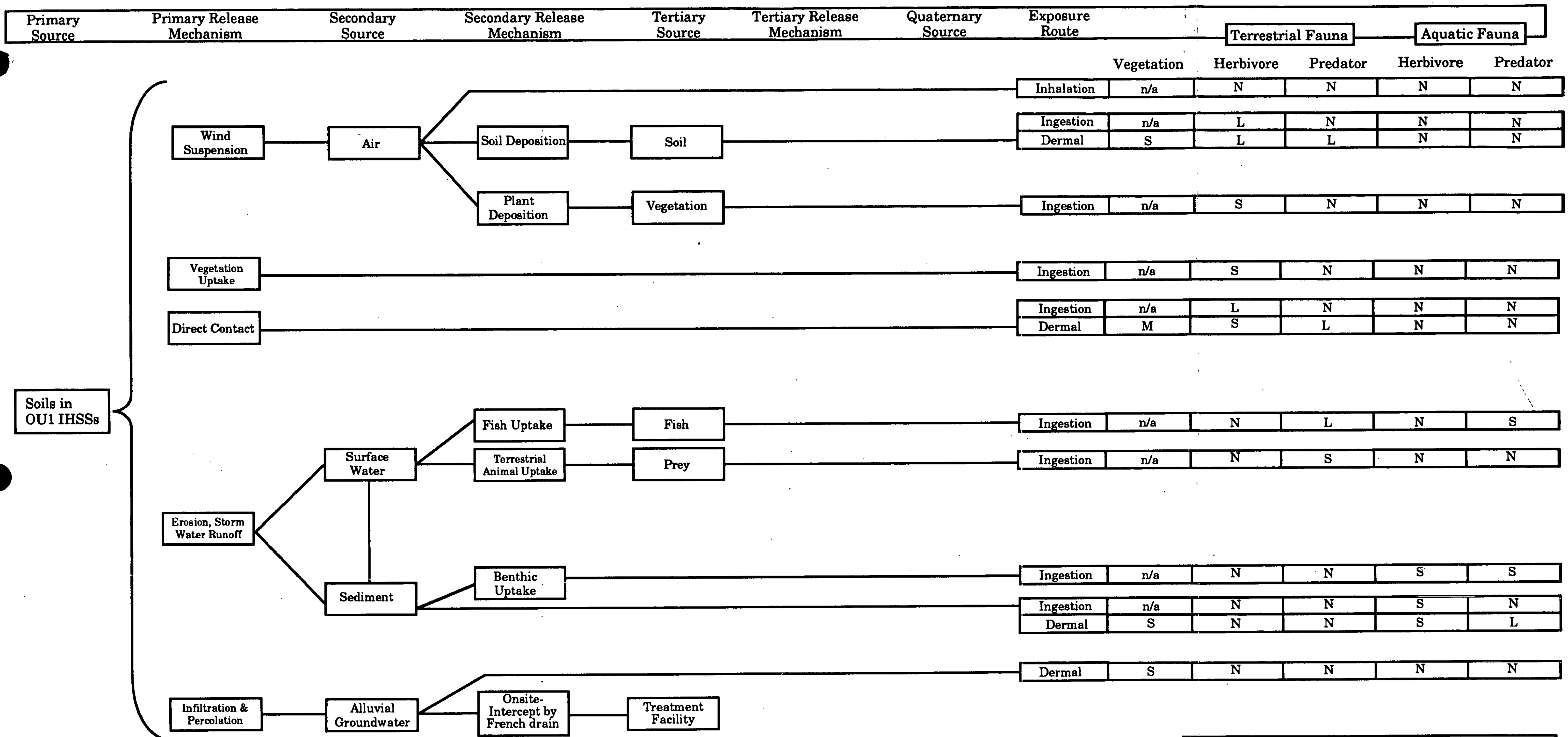
[a]Exposure estimations calculated using Eq. E6-1.

[b]Metal, PAH, and PCB concentrations are expressed in mg/kg, and radionuclides are expressed in nCi/kg.

[c]Value for lactating females.

[d]Metal, PAH, and PCB concentrations are expressed in mg/L, and radionuclides are expressed in nCi/L.

ND= not detected



Pathway	Exposure Route	Vegetation	Terrestrial Fauna Herbivore	Terrestrial Fauna Predator	Aquatic Fauna Herbivore	Aquatic Fauna Predator
Wind Suspension – Air	Inhalation	n/a	N	N	N	N
Wind Suspension – Air – Soil Deposition – Soil	Ingestion	n/a	L	N	N	N
	Dermal	S	L	L	N	N
Wind Suspension – Air – Plant Deposition – Vegetation	Ingestion	n/a	S	N	N	N
Vegetation Uptake	Ingestion	n/a	S	N	N	N
Direct Contact	Ingestion	n/a	L	N	N	N
	Dermal	M	S	L	N	N
Erosion, Storm Water Runoff – Surface Water – Fish Uptake – Fish	Ingestion	n/a	N	L	N	S
Erosion, Storm Water Runoff – Surface Water – Terrestrial Animal Uptake – Prey	Ingestion	n/a	N	S	N	N
Erosion, Storm Water Runoff – Sediment – Benthic Uptake	Ingestion	n/a	N	N	S	S
Erosion, Storm Water Runoff – Sediment	Ingestion	n/a	N	N	S	N
	Dermal	S	N	N	S	L
Infiltration & Percolation – Alluvial Groundwater	Dermal	S	N	N	N	N

Legend

S	Significant Potential Exposure Pathway (Conceivable and Relatively More Important)
L	Insignificant Potential Exposure Pathway (Conceivable, Though Not As Important)
N	Negligible and/or Incomplete Exposure Pathway (Unlikely to Occur)
n/a	Not analyzed

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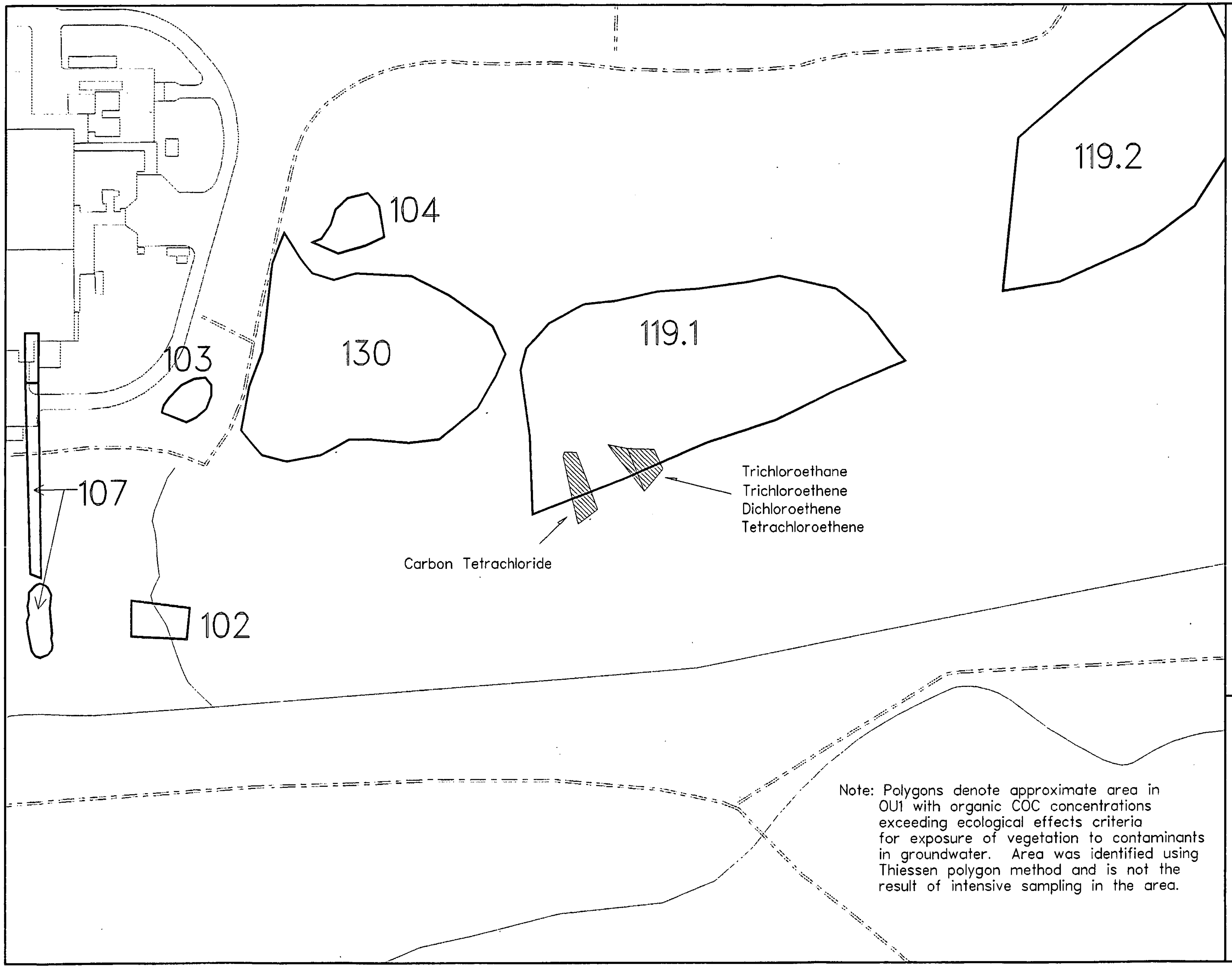
POTENTIAL EXPOSURE PATHWAYS

Figure E6-1 May 1994

M\ES\WM\EXP PTHWY OU1.mdw\5-16-94



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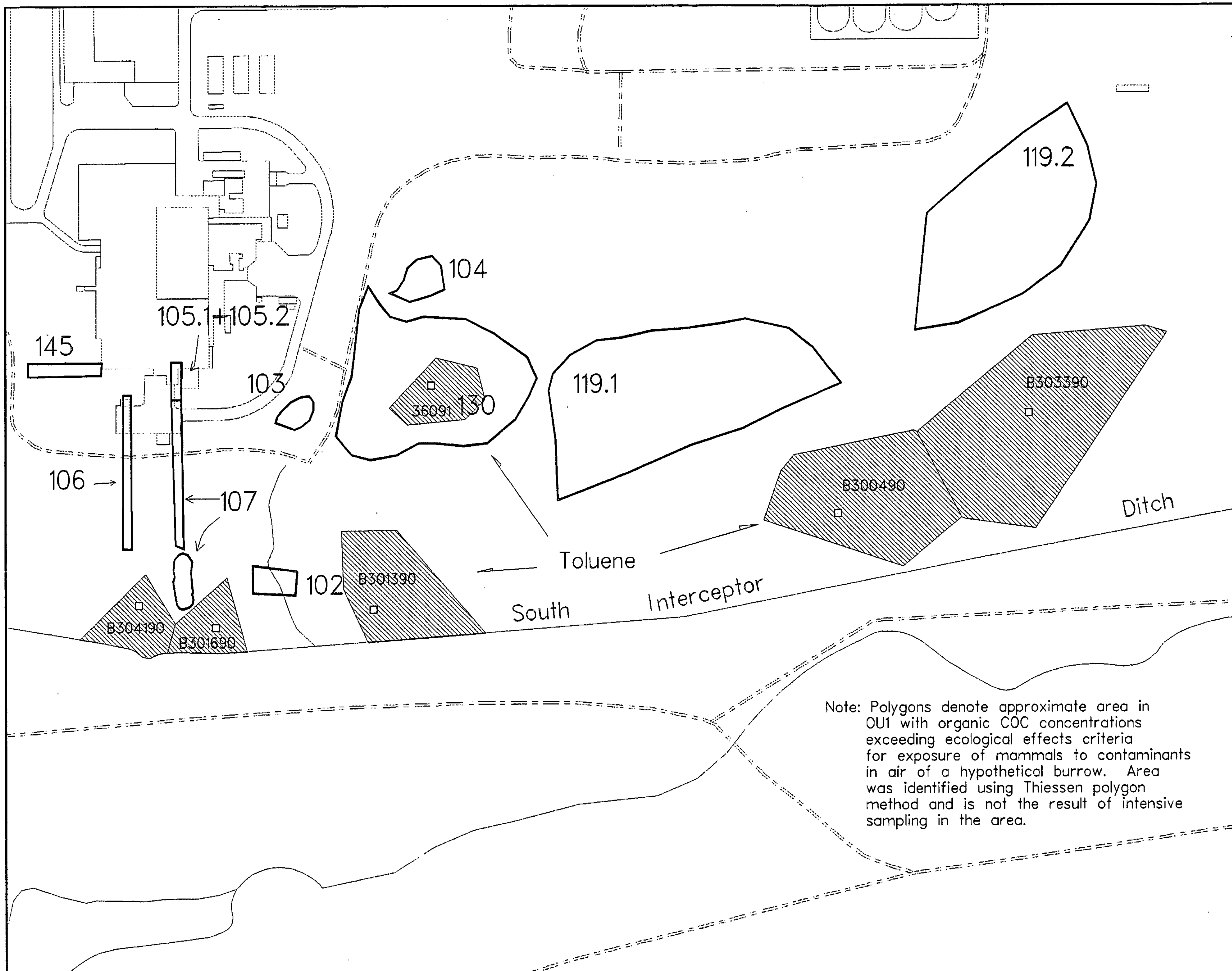
Exposure of Vegetation to Contaminants in Groundwater

Figure E6-11

08/10/93 oulmw2lhsn.map



Note: Polygons denote approximate area in OU1 with organic COC concentrations exceeding ecological effects criteria for exposure of mammals to contaminants in air of a hypothetical burrow. Area was identified using Thiessen polygon method and is not the result of intensive sampling in the area.

EXPLANATION

- Areas Exceeding Ecological Effects Criteria
- IHSS Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches, And Drainages
- Surface Water Impoundments
- Buildings

N

0 Meters 70 140

0 Feet 200 400

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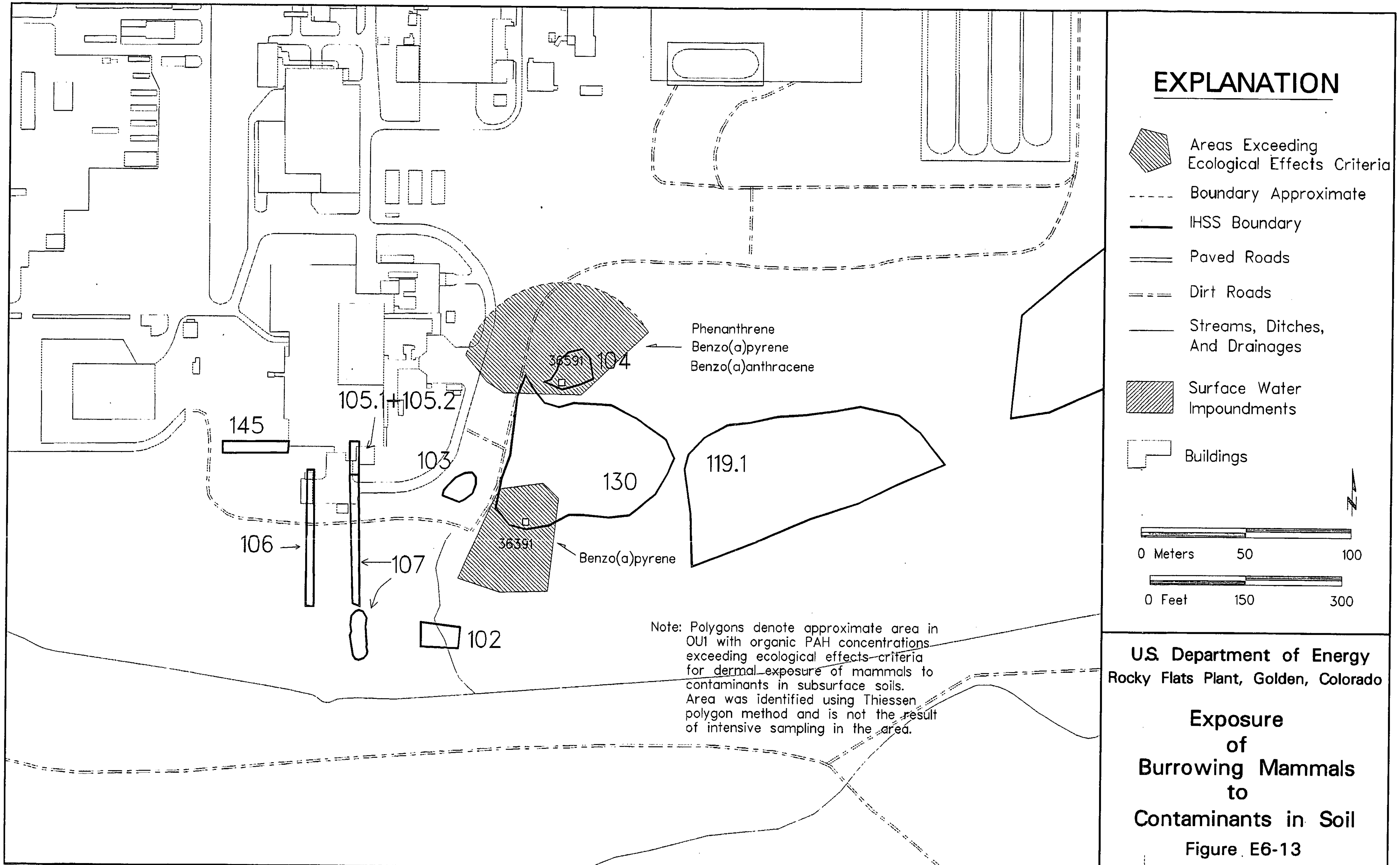
COC's Exceeding Ecological Effects Criteria for Exposure to Burrow Air

Figure E6-12

10/20/93 outcoc thsn.map



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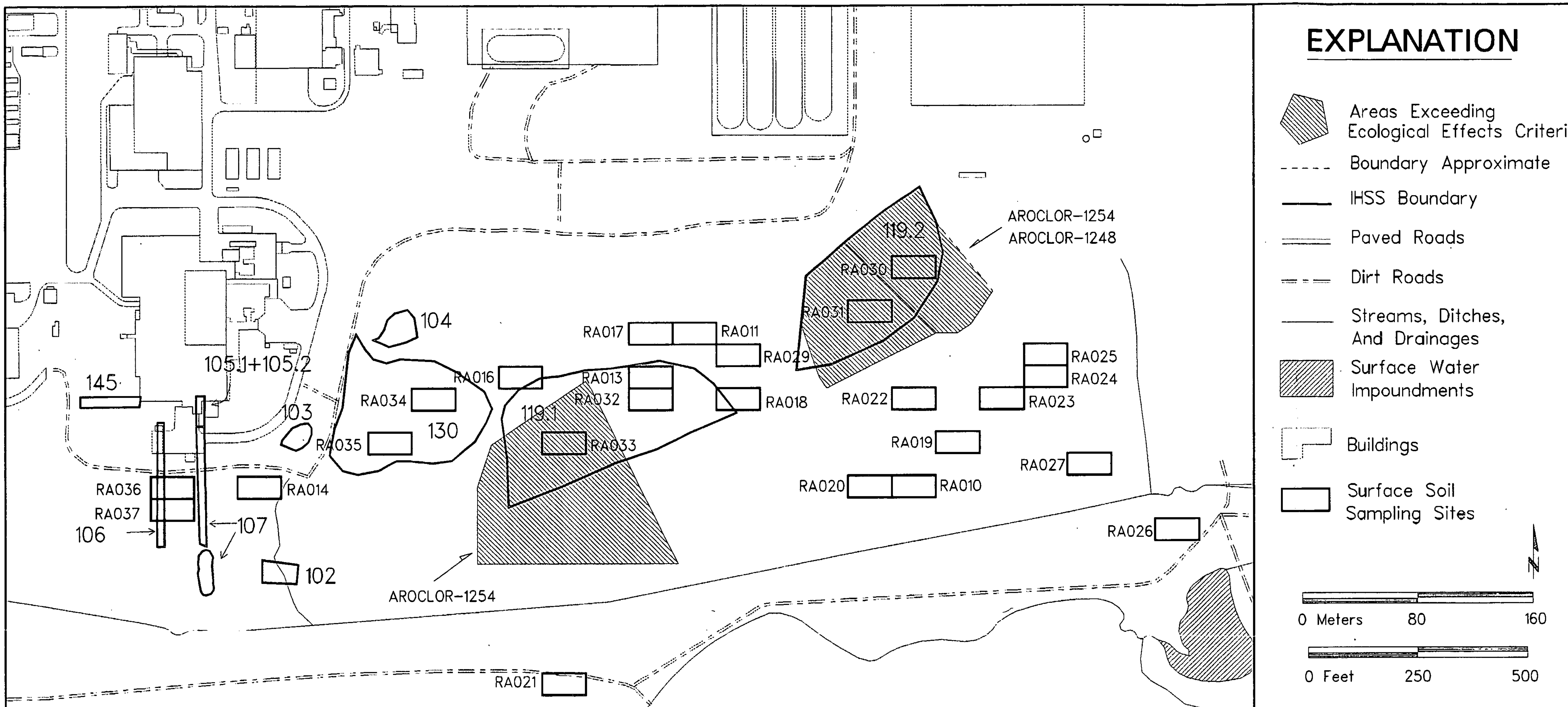
Exposure of Burrowing Mammals to Contaminants in Soil

Figure E6-13

08/16/93 outbore⊡thsn.map



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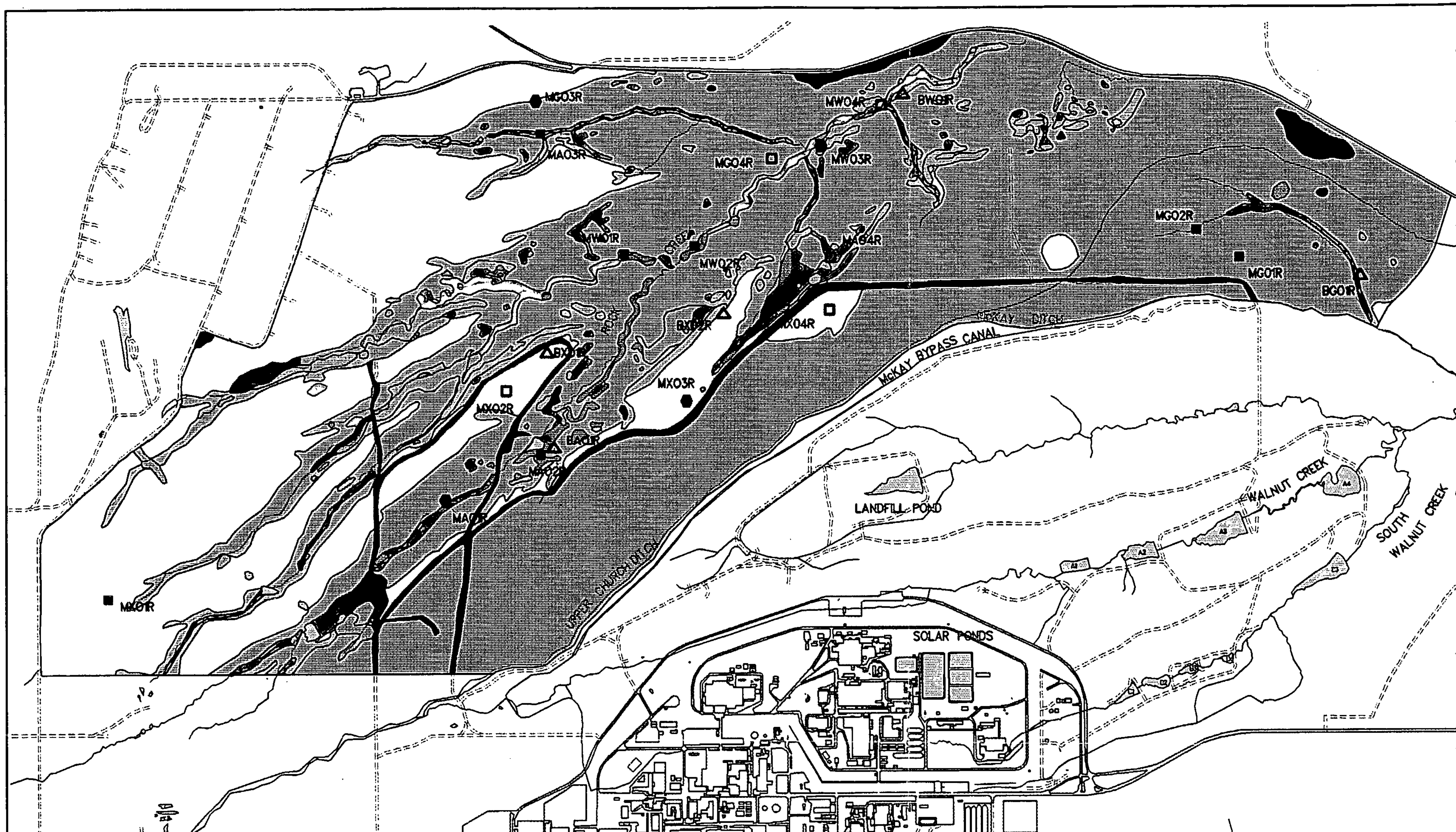
Soil PCB Concentrations Exceeding Ecological Effects Criteria

Figure E6-14

08/10/93 outspts\thsn.map



EXPLANATION

- △ Bird Survey Transect Start Point
- □ Small Mammals Site
- ■ Small Mammals/Vegetation Production Sample Site
- ● Small Mammals/Vegetation Tissue and Production Sample Site
- Paved Roads
- Streams, Ditches, And Drainages
- Surface Water Impoundments

N

0 Meters 500 1000

0 Feet 1500 3000

Vegetation Key

Wet Meadow	Bottomland Shrub (Leadplant)	Mesic Mixed Grassland
Short Marsh (Rushes)	Short Upland Shrub (Snowberry)	Xeric Mixed Grassland
Tall Marsh (Cattails)	Tall Upland Shrub	Reclaimed Grassland
Riparian Woodland	Short Grassland	Disturbed Area – Annual Grass/Forb
Ponderosa Pine	Mixed Grassland Complex	Disturbed Area – Barren Land

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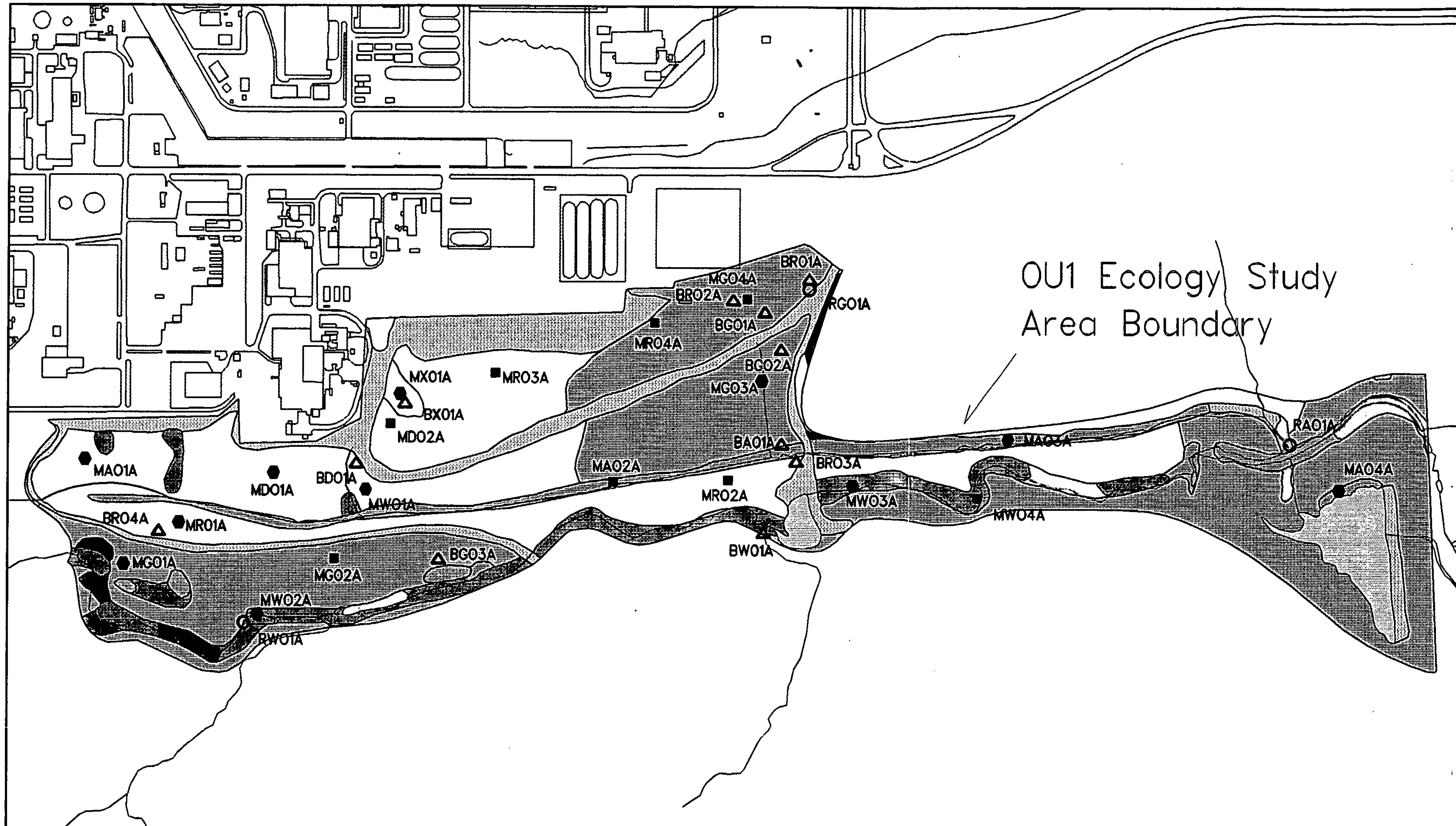
Reference Area Sampling Sites

Figure E7-1

05/11/94 REFVEG.MAP



EXPLANATION

△ Bird Survey Transect Start Point

○ Relative Abundance Transect Start Point

■ Small Mammal/Vegetation Tissue Sample Site

● Small Mammal/Vegetation Tissue and Production Sample Site

Paved Roads

Streams, Ditches, And Drainages

Surface Water Impoundments

N

0 Meters 200 400

0 Feet 600 1200

Vegetation Key

- Short Marsh (Rushes)
- Tall Marsh (Cattails)
- Riparian Woodland
- Bottomland Shrub (Leadplant)
- Short Upland Shrub (Snowberry)
- Short Grassland
- Mesic Mixed Grassland
- Xeric Mixed Grassland
- Reclaimed Grassland
- Disturbed Area/Barren Land

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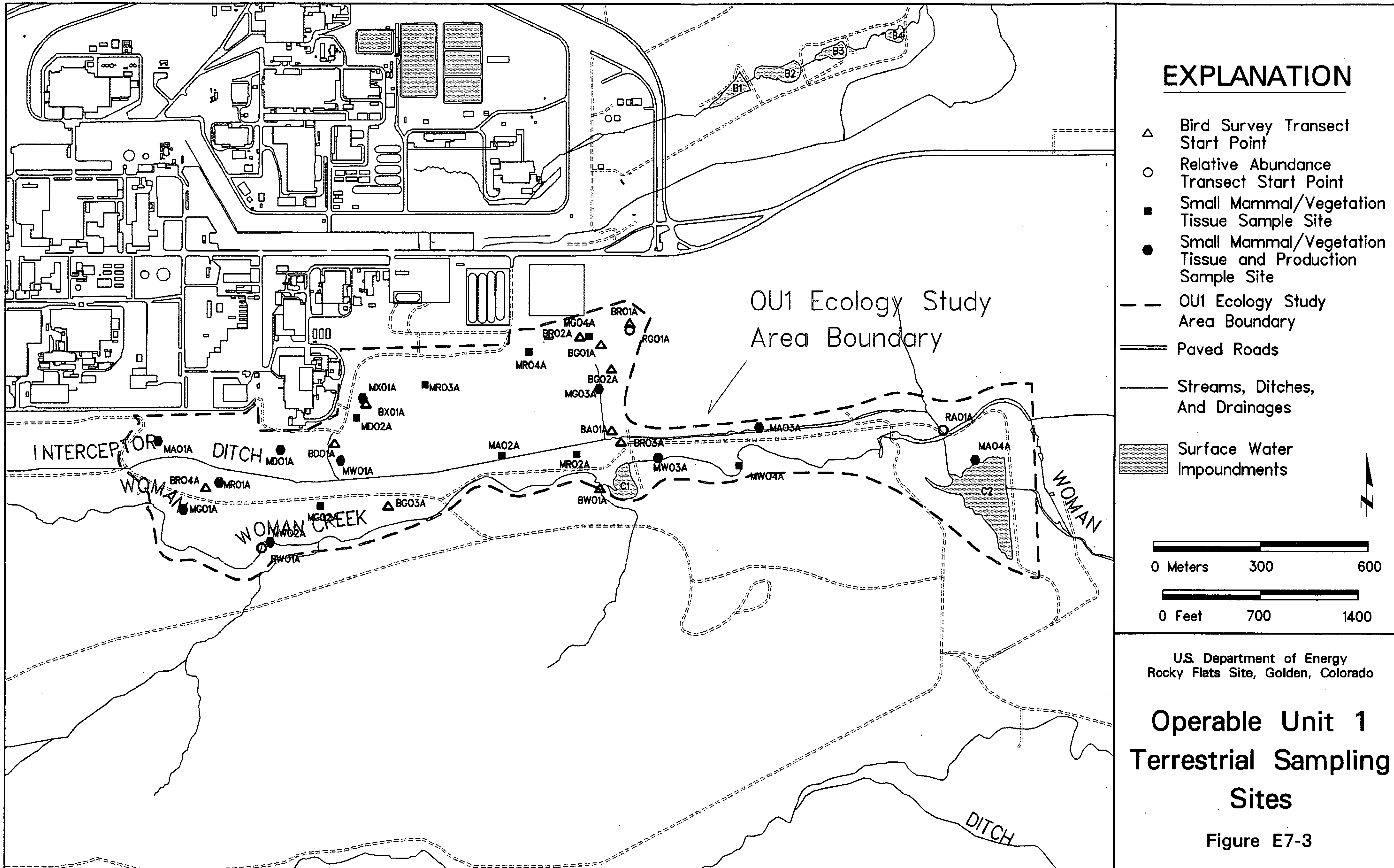
OU 1 Study Area Sampling Sites

Figure E7-2

05/11/94 OU1VEG.MAP



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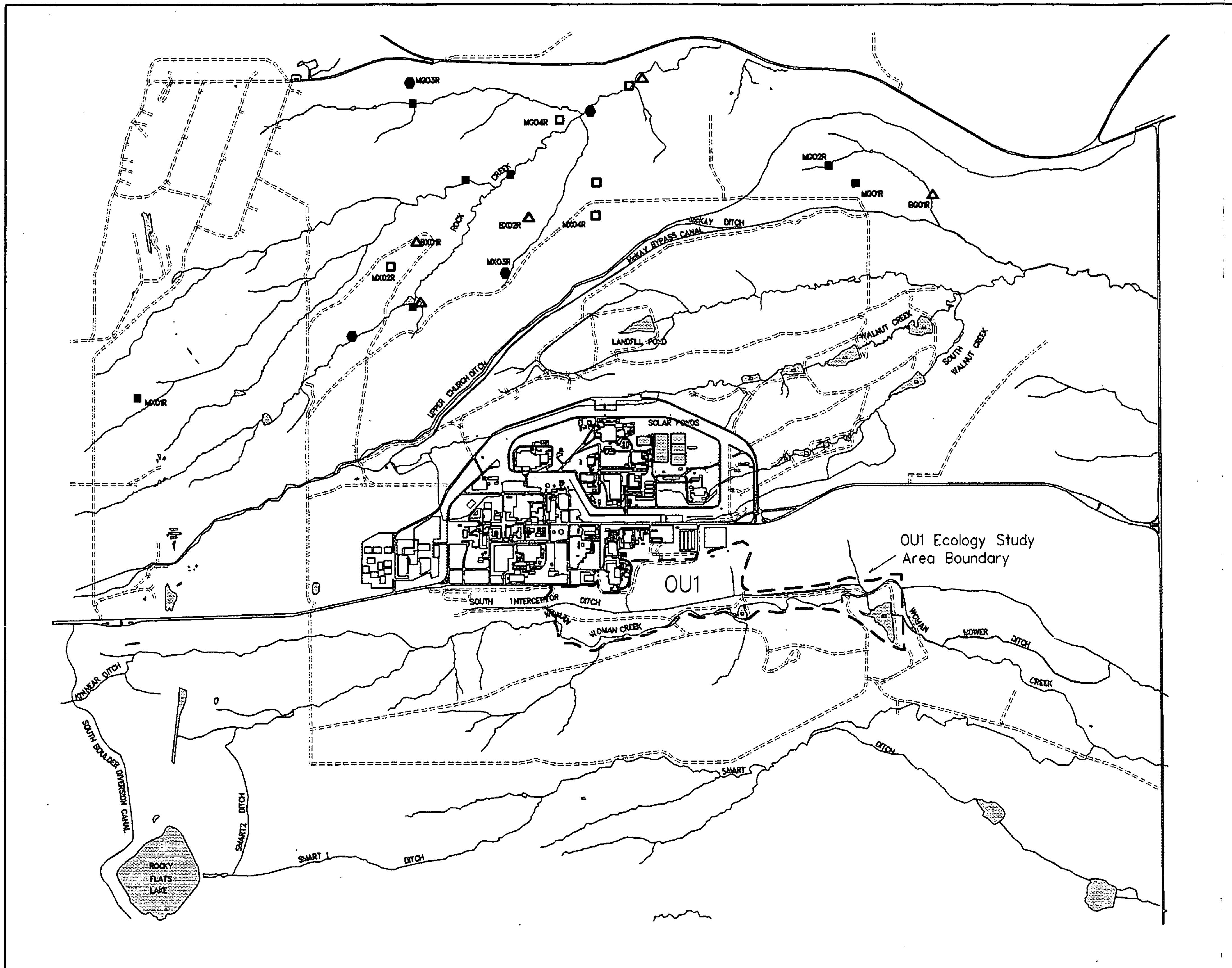
Operable Unit 1 Terrestrial Sampling Sites

Figure E7-3



EXPLANATION

△ Bird Survey Transect Start Point

□ Small Mammals Site

■ Small Mammals/Vegetation Production Sample Site

⬣ Small Mammals/Vegetation Tissue and Production Sample Site

— — OU1 Ecology Study Area Boundary

═ Paved Roads

— Streams, Ditches, And Drainages

Surface Water Impoundments

N

0 Meters 700 1400

0 Feet 2000 4000

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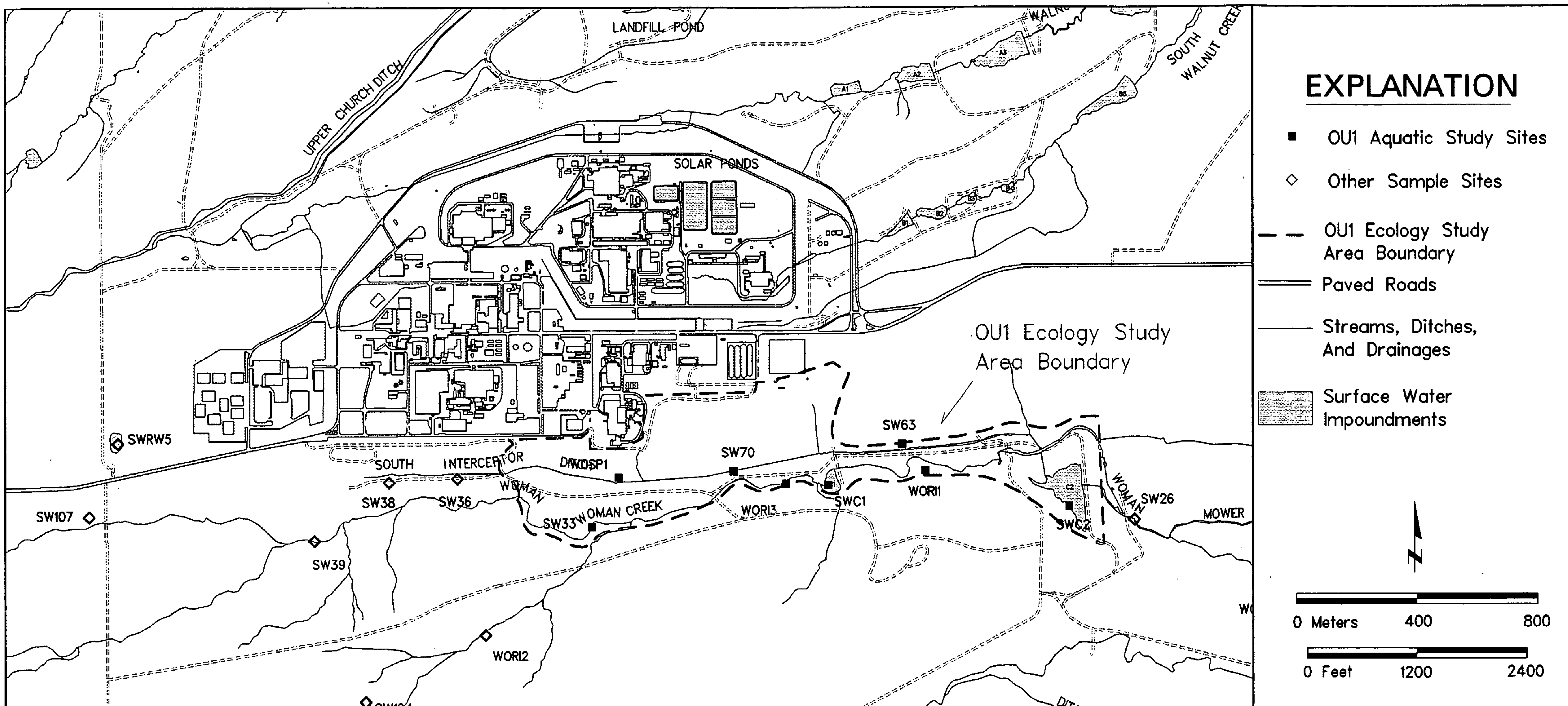
Operable Unit 1

Terrestrial Reference Sites

Figure E7-4

05/11/94 TERREREF.MAP



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Operable Unit 1 Aquatic Sampling Sites

Figure E7-5

05/11/94 AQUAESTUD.MAP

SW039

	Ceriodaphnia	Fathead Minnows
No. Survivors	10	18
pH Range	7.8-8.5	7.2-7.6
Alkalinity		90
Hardness		86

WOR13

	Ceriodaphnia	Fathead Minnows
No. Survivors	11	19
pH Range	8.1-8.6	7.6-7.8
Alkalinity		138
Hardness		150

WOR11

	Ceriodaphnia	Fathead Minnows
No. Survivors	15	19
pH Range	8.0-8.6	7.5-7.9
Alkalinity		200
Hardness		202

SW033

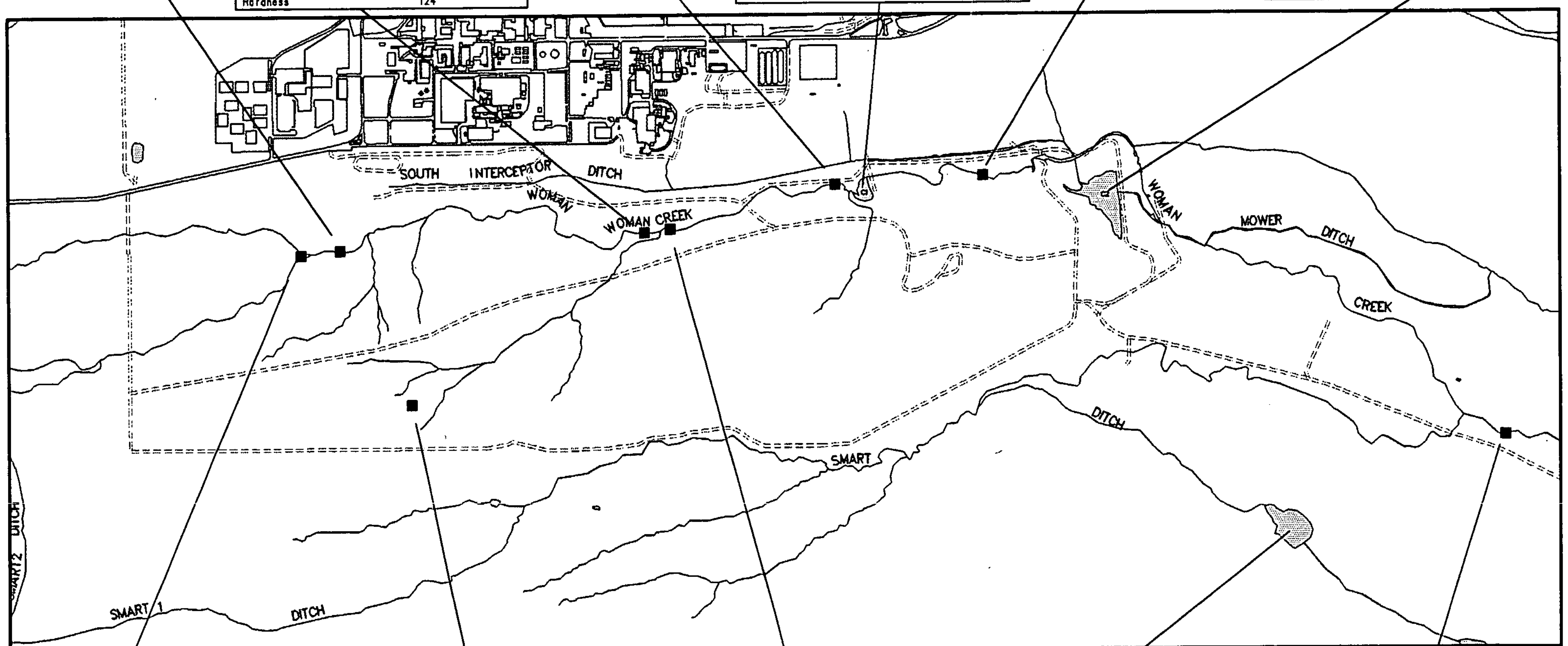
	Ceriodaphnia	Fathead Minnows
No. Survivors	5	18
pH Range	8.1-8.7	7.3-7.8
Alkalinity		138
Hardness		124

C-1

	Ceriodaphnia	Fathead Minnows
No. Survivors	20	20
pH Range	7.6-8.5	8.0-8.4
Alkalinity		165
Hardness		170
Total Ammonia		ND

C-2

	Ceriodaphnia	Fathead Minnows
No. Survivors	19	20
pH Range	7.7-8.6	8.2-8.5
Alkalinity		191
Hardness		173
Total Ammonia		ND



SW041

	Ceriodaphnia	Fathead Minnows
No. Survivors	7	20
pH Range	7.7-8.5	7.2-7.6
Alkalinity		87
Hardness		108

SW104

	Ceriodaphnia	Fathead Minnows
No. Survivors	12	10
pH Range	7.8-8.5	7.0-7.5
Alkalinity		88
Hardness		108

SW032

	Ceriodaphnia	Fathead Minnows
No. Survivors	10	20
pH Range	8.3-8.7	7.5-8.0
Alkalinity		136
Hardness		120

D-1

	Ceriodaphnia	Fathead Minnows
No. Survivors	19	20
pH Range	8.3-8.6	8.5-8.7
Alkalinity		219
Hardness		181
Total Ammonia		ND

WOPO2

	Ceriodaphnia	Fathead Minnows
No. Survivors	17	19
pH Range	7.8-8.6	7.3-8.0
Alkalinity		290
Hardness		220

Note: Toxicity screen results reported as survivors out of 20 organisms.

Units: Alkalinity (mg/L as CaCO3)
Hardness (mg/L as CaCO3)

EXPLANATION

- Sample Locations
- Paved Roads
- Streams, Ditches, And Drainages
- Surface Water Impoundments
- Buildings

N

0 Meters 500 1000

0 Feet 1600 3200

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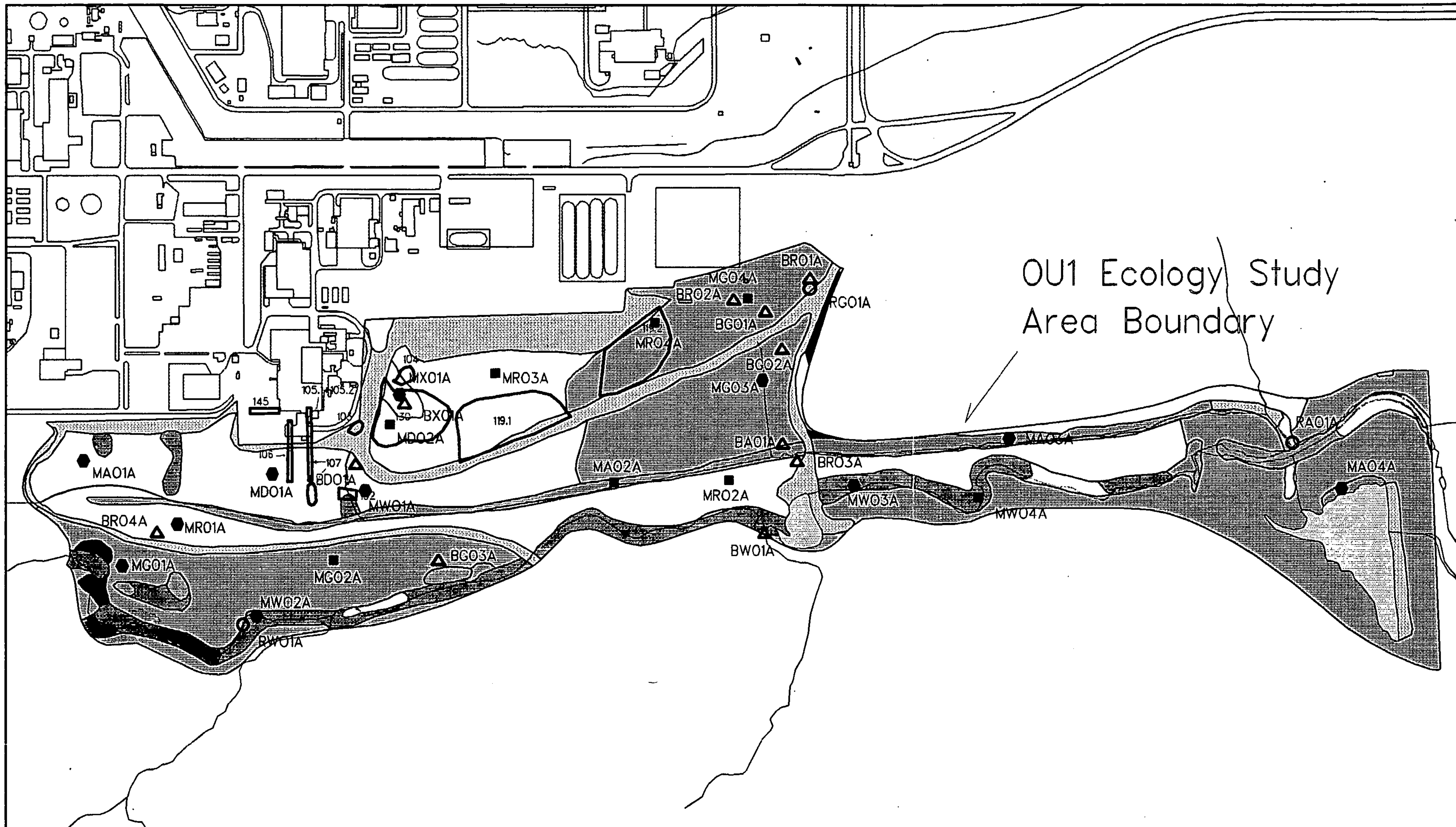
Results of Aquatic Toxicity Screening Woman Creek - 1991

Figure E7-6

05/12/94 WOMANCRK2.MAP



EXPLANATION

△ Bird Survey Transect Start Point

○ Relative Abundance Transect Start Point

■ Small Mammal/Vegetation Tissue Sample Site

● Small Mammal/Vegetation Tissue and Production Sample Site

Surface Water Impoundments

119.2 Individual Hazardous Substance Sites

0 Meters 200 400

0 Feet 600 1200

Vegetation Key

- Short Marsh (Rushes)
- Tall Marsh (Cattails)
- Riparian Woodland
- Bottomland Shrub (Leadplant)
- Short Upland Shrub (Snowberry)
- Short Grassland
- Mesic Mixed Grassland
- Xeric Mixed Grassland
- Reclaimed Grassland
- Disturbed Area/Barren Land

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Location of Individual Hazardous Substance Sites Relative to OU 1 Vegetation Communities

Figure E9-1

05/05/94 OU1IHSSVEG.MAP